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EXPERIMENTS WITH FALL-SOWN OATS IN THE SOUTH

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INTRODUCTION

It is recognized that fall-sown oats succeed better than spring-sown oats in most districts of the South. The one disadvantage which has retarded the growing of the crop more than any other has been occasional loss by winterkilling. The development of hardier and otherwise more satisfactory varieties and the determination of better cultural practices, therefore, are exceedingly important. In the Southern States grain production falls far short of local consumption. The rapid expansion of the livestock industry in these States is creating a greater need than ever for home production of feed crops. Oats meet an important rotation need in the scheme of farming and one sometimes difficult to fill by other crops. The value of any fall-sown cereal as a winter cover crop for the prevention of erosion also is a factor not to be overlooked in the South.

In this bulletin are assembled the available data from varietal and cultural experiments with fall-sown oats in the southeastern United States. Conclusions and recommendations which seem to be warranted by the data also are presented.

IMPORTANCE OF THE OAT CROP

According to 1920 census data and the annual estimates of the Bureau of Agricultural Economics, United States Department of Agriculture, the 16 Southern States, including Delaware, Maryland, West Virginia, Kentucky, Arkansas, Oklahoma, and those southward, grow approximately 5,000,000 acres of oats annually. From 12 to 15 per cent of the total oat acreage for the United States is grown in these States. Government estimates are not made on the fall-sown oat acreage in the South, but such information as is available indicates that roughly from 2,000,000 to 3,000,000 acres of fall-sown oats are grown in the area outlined. Approximately half of the total southern oat acreage is fall sown. In the Carolinas, Georgia, Alabama, Mississippi, and Louisiana the fall-sown acreage usually is greater than that sown in spring, whereas in Virginia, Tennessee, Arkansas, and Texas the spring-sown acreage predominates.

When fall-sown oats are injured severely by winterkilling, the ratio between the harvested spring-sown and fall-sown acreages is sometimes greatly altered. Likewise, immediately following such seasons there usually is a slump in the fall-sown acreage. This is shown by the data of Table 1, being estimated[1] acreages for Georgia, one of the leading fall-sown oat States, covering the years 1923 to 1926, inclusive.

Table 1.—*Estimated acreages and average yields for Georgia of harvested spring-sown and fall-sown oats and the percentage of the total represented by each during stated years*

Year harvested	Acreage harvested[1]			Percentage of total harvested acreage		Average acre yield (bushels)	
	Spring sown	Fall sown	Total	Spring sown	Fall sown	Spring sown	Fall sown
1923	109, 410	411, 590	521, 000	21	79	11. 5	20. 0
1924	192, 500	82, 500	275, 000	70	30	16 0	19. 0
1925	123, 900	289, 100	413, 000	30	70	12. 5	18. 0

[1] No estimates on acreage sown are available.

The data in Table 1 show that in 1923 when winterkilling did not materially reduce stands the harvested oat acreage in Georgia consisted of about one-fifth spring sown and four-fifths fall sown. This is the usual ratio under normal conditions. The figures for 1924 show the reduction in total harvested acreage and the relatively great increase in spring-sown acreage resulting from the severe winterkilling of the fall-sown crop which occurred during the winter of 1923-24. The reaction following the losses of the winter of 1923–24 persisted into the following year, as shown by the decreased fall-sown acreage and the still slightly increased spring-sown acreage of 1925.

Table 1 also shows the low average acre yield of oats in the South. This is one of the factors which has limited southern oat production. During the seven-year period from 1914 to 1920, inclusive, the average acre yield of oats in the South was about 23 bushels, as compared with a little over 33 bushels for the entire United States. The encouraging feature is the increase in production which the data of Table 1 also show is possible from growing fall-sown oats. The wider use of better adapted and more hardy strains of fall-sown oats, together with better cultural practices, will make it possible to increase yields still further.

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[1] These data were supplied by V. C. Childs, agricultural statistician of the Georgia Cooperative Crop Reporting Service.

CLIMATIC FACTORS

It is not possible to place definitely the northern limits of successful fall-sown oat culture. Winter temperature undoubtedly is the limiting factor in the production of the crop. Studies by Salmon (*6*)[2] on the relation of winter temperature to the distribution of winter and spring grains in the United States indicate that winter oats are adapted to the region lying south of the isotherm of 30° F. In Figure 1 are shown the locations of the isotherms of 10°, 20°, and 30° and the distribution of oats in the United States in 1919. Between the isotherms of 30° and 20° both fall-sown and spring-sown oats are grown. North of the isotherm of 20° fall-sown oats usually do not survive the winter, and spring-sown oats produce better average yields. The northern limits of successful fall-sown oat culture are roughly marked by the States of Maryland, Virginia, Kentucky, Tennessee, Arkansas, and Oklahoma. South of these States in the Cotton Belt, oats when fall sown are grown more successfully than when spring sown. Fall-sown oats occasionally suffer severe winter injury even in this latter area, but the yields are so much superior on the average to the spring-sown crop that there is no question of relative values.

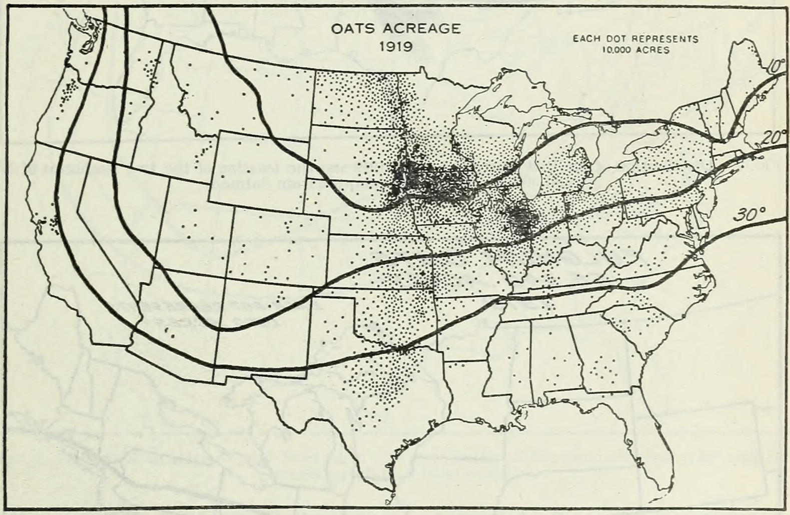

FIG. 1.—Distribution of the oat acreage in 1919 and the location of the three isotherms of 10°, 20°, and 30° F. (Isotherms adapted from Salmon)

The distribution of fall-sown oats in the South is illustrated by the distribution in 1919 of the three leading varieties. This distribution, determined by a varietal survey, is shown in Figures 2, 3, and 4. The Red Rustproof and Fulghum varieties are confined almost entirely to the area south of isotherm 20° F. The Winter Turf variety is grown in the area between the isotherms of 20° and 30° F. This distribution of varieties shows a rather definite relationship between varietal type and climate. In the northern part of the winter-oat

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[2] Italic numbers in parentheses refer to "Literature cited" p. 32.

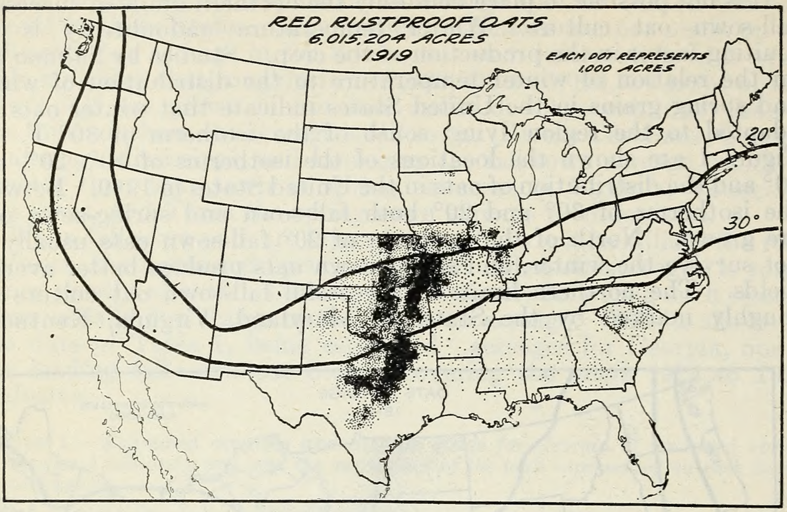

FIG. 2.—Distribution of the Red Rustproof oat in 1919 and the location of the two isotherms of 20° and 30° F. (Isotherms adapted from Salmon)

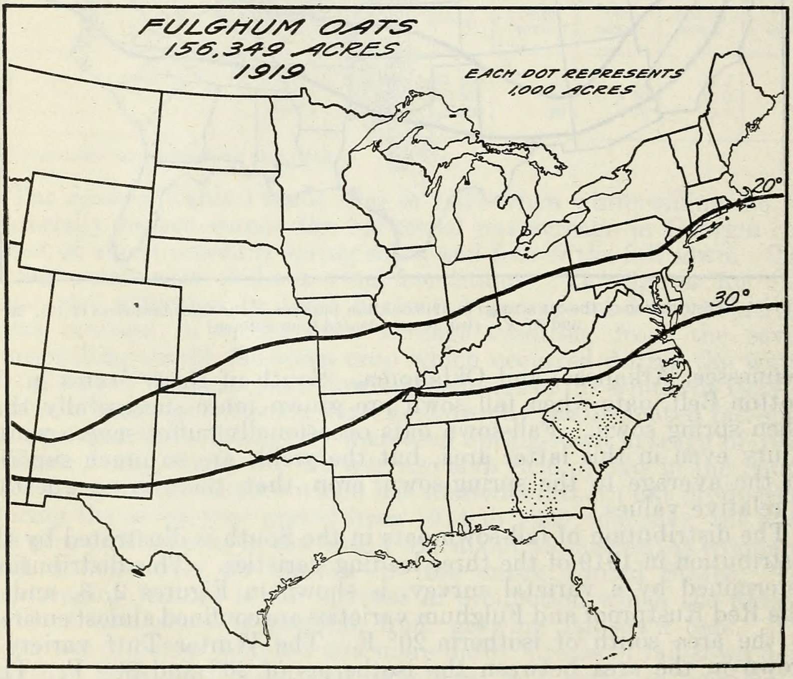

FIG. 3.—Distribution of the Fulghum oat in 1919 and location of the two isotherms of 20° and 30° F. The distribution of Fulghum both as a fall-sown and a spring-sown variety has increased materially since 1919. (Isotherms adapted from Salmon)

territory the hardier and less heat-resistant winter varieties of common oats (*Avena sativa*), such as Winter Turf, Culberson, and Hatchett, are best adapted and can be grown successfully. South of this, where higher winter temperatures prevail, the less hardy but more heat-resistant Red Rustproof and Fulghum varieties of the red oat (*A. byzantina*) group are the only types grown or at all well adapted. The northward advancement of the winter-oat belt can be accomplished only by discovering or developing varieties hardier than those now available.

Two major factors are instrumental in winterkilling or winter injury of oats. These are root exposure and injury from heaving and injury or death of the plants from low temperatures, especially in the absence of a snow covering. Alternate freezing and thawing, especially in the spring, often cause severe heaving, pulling the plant roots from the soil and otherwise injuring and breaking the roots. A prolonged period of temperatures below zero, especially when accompanied by winds and with no snow blanket to protect the plants, is usually fatal to the winter-oat crop. A period of warm weather in winter or early spring which encourages growth and high moisture content of the plants, followed by freezing weather, also results in winterkilling or injury to oats.

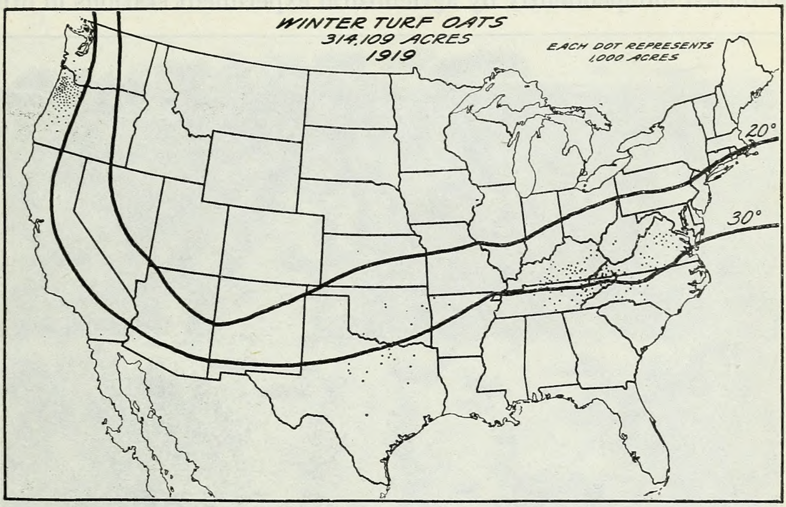

FIG. 4.—Distribution of the Winter Turf oat in 1919 and location of the two isotherms of 20° and 30° F. (Isotherms adapted from Salmon)

There apparently is a rather definite relationship between the growth habit of the young plant and cold resistance in winter oats. Usually the varieties showing a decidedly prostrate or spreading habit in early growth are the most winter resistant. Differences in growth habit of the three important fall-sown oat varieties, Winter Turf, Red Rustproof, and Fulghum, are shown in Plate 1. A fall-sown oat nursery at the Arlington Experiment Farm in which certain varieties and strains have been injured by winterkilling is shown in Figure 5.

LOCATION OF EXPERIMENTS

The Office of Cereal Crops and Diseases of the Bureau of Plant Industry for a number of years has conducted experiments with fall-sown oats at the Arlington Experiment Farm, Rosslyn, Va., near Washington, D. C. Varietal and cultural experiments also have been conducted cooperatively in Georgia by the Georgia State College of Agriculture and the Office of Cereal Crops and Diseases. These experiments were located at the Georgia State College of Agriculture, Athens, Ga., at the Coastal Plain Experiment Station, and the South Georgia Agricultural and Mechanical School, Tifton, Ga., at the farm of J. S. Shingler, Auburn, Ga., and at the county farm, Quitman, Ga. Summarized average data from varietal experiments conducted independently by agricultural experiment stations in other Southern States also are presented. It is realized that the data last mentioned are meager and from scattered sources, but they are included to make the information on the behavior of fall-sown oat varieties as complete as possible.

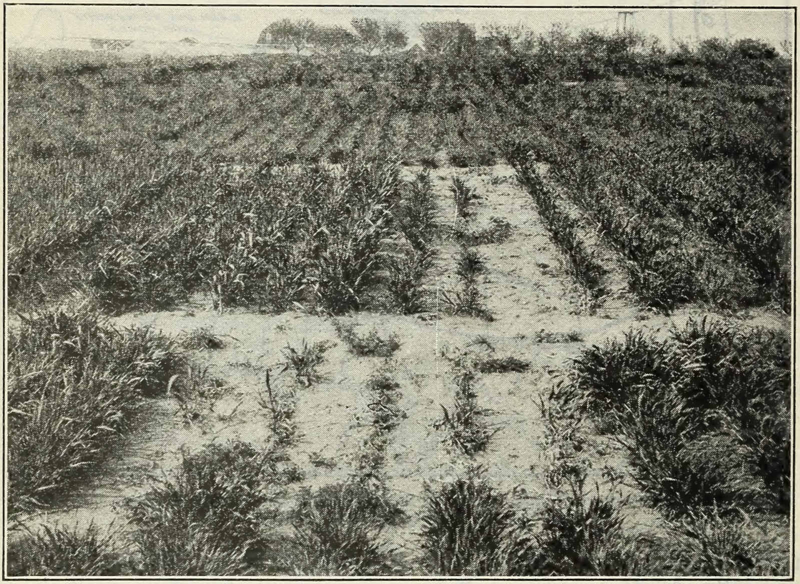

FIG. 5.—Fall-sown oat nursery at the Arlington Experiment Farm in early spring. Effects of winter killing are seen in the foreground

VARIETAL EXPERIMENTS

The determination of the adaptation and yielding power of varieties always is one of the most important phases of crop-improvement investigations. Much of the information now available on fall-sown oats has been obtained from varietal experiments.

RESULTS AT THE ARLINGTON EXPERIMENT FARM IN VIRGINIA

The location and history of the Arlington Experiment Farm, with descriptions of climate, soil type, soil treatment, experimental methods, etc., have been presented fully in earlier publications (*7*, *9*).

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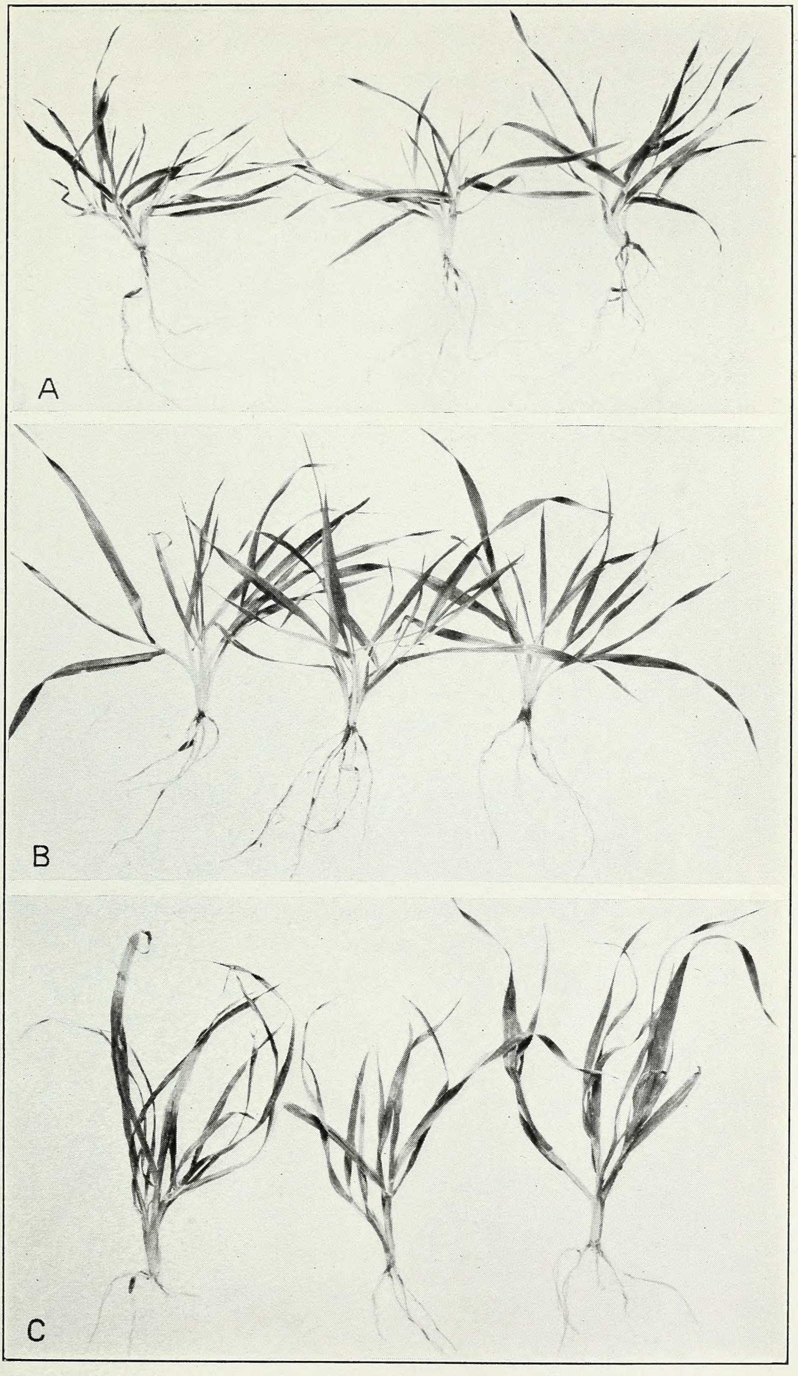

EARLY GROWTH HABITS OF LEADING VARIETIES OF FALL-SOWN OATS

A, Winter Turf; B, Red Rustproof; C, Fulghum. As a rule, habit is an indication of the degree of winter hardiness or cold resistance. In these three varieties it may be described as spreading, semispreading, and semierect, respectively.

TABLE 2.—*Acre yields (bushels) of 26 fall-sown oat varieties and strains[1] grown at Arlington Experiment Farm in stated years*

Group and variety	C. I. No.	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	Average 1911 to 1925	Average 1916 to 1925	Average 1922 to 1925
Winter Turf:																			
Winter Turf	431	29.4	25.3	40.0	61.9	69.0	51.6	59.1	45.4	68.3	21.4	73.5	57.0	57.4	70.9	52.0	52.1	55.7	59.3
Do	435–4						63.6	67.9	60.6	76.5	21.0	86.9	62.4	61.3	81.5	57.3		63.9	65.6
Do	541–4						63.3	65.0	53.4	82.9	8.9	98.7	59.6	63.4	79.2	58.7		63.3	65.2
Culberson:																			
Culberson	273	40.9	19.5	33.5	54.6	51.0	38.9	57.6	57.0	71.6	19.7	67.3	53.2	64.5	65.8	59.5	50.3	55.5	60.8
Do	273–I–14						29.0	50.3	55.0	73.8	18.8	58.1	61.3	62.5	63.6	57.5		53.0	61.2
Dwarf Culberson	748						25.2	53.8	53.6	64.6	16.3	45.1	68.9	52.1	61.9	44.2		48.6	56.8
Bicknell:																			
Bicknell	206	33.1	4.7	36.6	59.1	30.5	39.7	51.3	45.5								[2] 47.9	[2] 55.4	
Do	206–155									72.5	15.0	70.4	69.8	70.3	53.6	65.9			64.9
Hatchett:																			
Hatchett	838										13.6	59.0	59.9	65.4	56.7	70.9			63.2
(Unnamed)	691												41.9	54.0	58.8	48.8			50.9
Tech (Hutcheson selection)	947												55.5	56.1	49.1	78.9			59.9
Red Rustproof:																			
Red Rustproof	518–3	63.1	5.9	43.4	61.9	38.6	23.5	45.4	64.8	55.2	[3] 0	55.3					[4] 43.4	[4] 43.9	
Do	1815											30.9	62.9	45.4	43.1	43.0			48.6
Red Rustproof (Ferguson No. 71)	844														33.3	57.9			
Culred	518–189												40.2	62.9	57.2	31.8			48.0
Fulghum:																			
Fulghum	708				59.5	37.4	27.8	41.4	53.9	70.6	6.6	43.4	68.7	66.4	49.9	[5] 77.0		50.6	65.5
Kanota	839												70.3	68.6	49.4	[5] 75.2			65.9
Miscellaneous:																			
Aurora	831				81.3	29.4	38.6	26.3	53.1	66.0	11.8	67.6	56.0	66.1	50.9	[5] 45.9		48.2	54.7
Custis (1001 d1–1B)	2041												68.4	69.1	69.0	67.0			68.4
Navarro (Ferguson Navarro)	966												64.2	35.6	24.5	39.5			41.0
Lee (1001 f1–1B)	2042												55.0	71.7	74.0	77.8			69.6
Randolph (1001 h1–4B)	2275												57.1	70.0	66.8	67.3			65.3
Jackson (1001 f1–1Bx)	2276												51.4	64.5	61.9	66.2			61.0
Winter Turf×Aurora (1001 d1–4–3B)	2277														61.6	77.8			
Dwarf Culberson×Fulghum	2278														34.6	40.0			
Fulghum×Hatchett	2279														46.3	67.5			

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[1] Yield data on 26 additional varieties and selections which gave little promise in the one or more years included in the experiments are not reported herein; for data on these selections, see Taylor (*9*).

[2] Combined yield records of the two Bicknell strains are considered in these averages.

[3] Completely winterkilled.

[4] Combined yield records of Red Rustproof strains, C. I. Nos. 518–3 and 1815; yield of former used for 1921.

[5] Yield for nursery rows; yields from plots not comparable, being inadvertently mixed with another variety.

PLOT EXPERIMENTS

During the period from 1911 to 1925, inclusive, 55 strains of fall-sown oats, representing about 11 more or less distinct varietal types, were grown in duplicated twentieth-acre or triplicated fortieth-acre field plots at the Arlington Experiment Farm. A number of these strains were tested for only short periods and were then discarded. Only the data from the varieties which have been grown continuously since 1911 and those which have been added in later years and have been continued to date are presented in this bulletin. Data obtained on varieties of minor importance are not presented. The data on the varieties discarded with the ending of the 1923 season have been published by Taylor (*9, p. 9*).

In Table 2 are given annual and average acre-yield data of 26 varieties and selections[3] of fall-sown oats grown at the Arlington Experiment Farm for two or more years during the 15-year period from 1911 to 1925, inclusive.

Of the 26 varieties on which data are presented in Table 2, only 2 were grown for the entire period. These were Winter Turf (C. I. No. 431) and Culberson (C. I. No. 273). The average acre yield of the former was 52.1 bushels and of the latter 50.3 bushels. In 10 years Winter Turf outyielded Culberson; in 5 years Culberson gave the better yields. The average yield of Culberson was 1.8 bushels less than that of Winter Turf.

In 9 of the 15 years the average yields of each of these two varieties exceeded 50 bushels per acre, and in 6 years one or both of them yielded in excess of 60 bushels per acre. In 4 years the average yield of the two varieties was less than 40 bushels per acre, in 2 of which, 1912 and 1920, especially light crops were harvested. To summarize, in 15 years 9 good to excellent crops, 4 fair crops, and 2 very light crops were harvested.

During the last 15 years the average acre yield of fall-sown oats in the varietal experiments at Arlington has increased steadily. A comparison of the yields obtained from the same variety shows considerable change. During the first five-year period from 1911 to 1915, inclusive, the average yield of the two varieties, Winter Turf and Culberson, was 42.5 bushels per acre; whereas in the second five-year period from 1916 to 1920 the average yield of these two varieties was 49.1 bushels per acre, an increase of 6.6 bushels. In the last five-year period, 1921 to 1925, inclusive, the average increase yield was 19.6 bushels greater than that for the first five-year period and 13 bushels greater than for the second five-year period. The average yield for the five-year period from 1921 to 1925 for these two varieties was 62.1 bushels.

Several factors probably have contributed to this result. Soil conditions have improved on the Arlington Experiment Farm, owing to the continued use of commercial fertilizers, stable manure, and green-manuring crops. This has resulted in increased soil fertility and consequent higher acre yields. Natural selection also may have been partially responsible for increased yields. The older oat varieties are by no means homozygous, but contain numerous distinct strains. In growing a variety continuously under severe winter conditions which require a high degree of hardiness for survival, the weaker, less hardy strains one by one have been lost and only the more hardy ones remain. This may have resulted in hardier and more productive mass varieties during later years.

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[3] All Cereal Investigations (C. I.) numbers and Georgia station numbers in this and succeeding tables followed by dash and additional numeral or numerals indicate selections of the varieties named.

Among the varieties grown for 10 years or longer, the Winter Turf selections (C. I. Nos. 435–4 and 541–4) have outyielded all others. (Fig. 6.) These selections were made by C. W. Warburton [4] at the Arlington Experiment Farm in 1908. Owing to their rather undesirable kernel color and very late maturity, characteristics common to all Winter Turf oats, these improved strains have been distributed to only a very limited extent. Yields of these two strains have not varied greatly one from the other, and the two have outyielded the original Winter Turf (C. I. No. 431), otherwise the oat variety giving the highest 10-year average yield at Arlington, by about 8 bushels to the acre as an average.

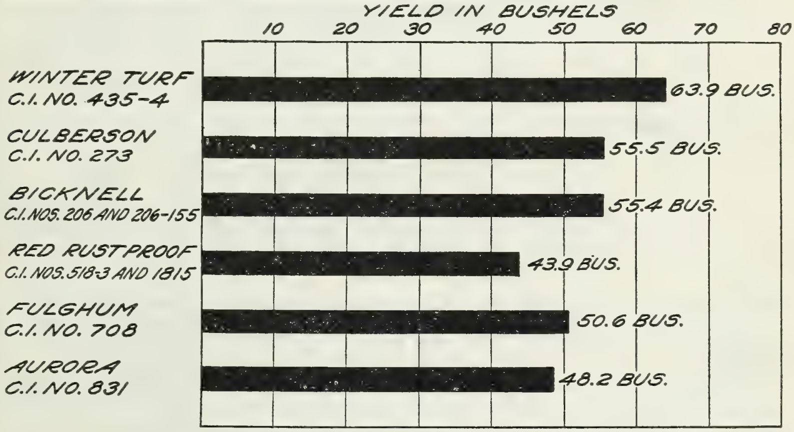

FIG. 6.—Average acre yields of leading strains of fall-sown oats in each of six varietal groups grown in field plots at the Arlington Experiment Farm during the 10-year period from 1916 to 1925, inclusive

In the Culberson group only three strains have been grown for 10 years or longer. None of these strains has shown particular promise as compared with the Winter Turf selections, although Culberson (C. I. No. 273) has yielded approximately as much as the original Winter Turf.

But one strain of Bicknell is now grown at Arlington Farm. While the average yield data of this selection and the original Bicknell variety compare favorably with the original Winter Turf and Culberson, the selection is not so good as the Winter Turf selections.

In the Red Rustproof group no strain has been grown continuously for the 10-year period from 1916 to 1925, inclusive. The combined yield data for the two Red Rustproof strains (C. I. Nos. 518–3 and 1815) are presented. The yields of these selections compare very poorly with those of the strains previously discussed. The average yield is just 20 bushels less than that of the best Winter Turf strain.

Red Rustproof is far less winter hardy than Winter Turf, the most hardy type known, or even than Culberson or Bicknell, these latter being about equal to Winter Turf in hardiness and ranking next to it. Winter hardiness is an important factor in the adaptability of oat varieties at Arlington Farm. The lower yield of Red Rustproof is owing to lack of hardiness, resulting in reduced stands and yields. Of the three Red Rustproof strains now being grown at Arlington Farm, none is sufficiently winter hardy to warrant increase or distribution in the northern part of the winter-oat territory. Culred (C. I. No. 518–189), a variety belonging to the *Avena byzantina* group, with whitish kernels, has been even less promising. In nursery experiments this strain has produced very high yields, and the low yields obtained in field plots are difficult to explain.

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[4] C. W. Warburton, Director of Extension Work of the United States Department of Agriculture, formerly agronomist in charge of oat investigations in the Office of Cereal Crops and Diseases.

TABLE 3.—*Comparison of average acre yields of all varieties of fall-sown oats in Table 2 with those of Winter Turf and Lee for comparable years at Arlington Experiment Farm*

Group and variety	C. I. No.	Comparison with Winter Turf (C. I. No. 431)					Comparison with Lee (C. I. No. 2042)				
		Number of years comparable	Average yields (bushels)			Percentage of yield of Winter Turf, same years	Number of years comparable	Average yields (bushels)			Percentage of yield of Lee, same years
			Period	Winter Turf, same years	Deviation from Winter Turf			Period	Lee, same years	Deviation from Lee	
Winter Turf:											
Winter Turf	431	------	------	------	------	100.0	4	59.3	69.6	−10.3	85.2
Do	435–4	10	63.9	55.7	+8.2	114.7	4	65.6	69.6	−4.0	94.3
Do	541–4	10	63.3	55.7	+7.6	113.6	4	65.2	69.6	−4.4	93.7
Culberson:											
Culberson	273	15	50.3	52.1	−1.8	96.5	4	60.8	69.6	−8.8	87.4
Do	273–I–14	10	53.0	55.7	−2.7	95.2	4	61.2	69.6	−8.4	87.9
Dwarf Culberson	748	10	48.6	55.7	−7.1	87.3	4	56.8	69.6	−12.8	81.6
Bicknell:											
Bicknell	206	8	37.6	47.7	−10.1	78.8	------	------	------	------	------
Do	206–155	7	59.6	57.2	+2.4	104.2	4	64.9	69.6	−4.7	93.2
Hatchett:											
Hatchett	838	6	54.3	55.4	−1.1	98.0	4	63.2	69.6	−6.4	90.8
(Unnamed)	691	4	50.9	59.3	−8.4	85.8	4	50.9	69.6	−18.7	73.1
Tech (Hutcheson selection)	947	4	59.9	59.3	+.6	101.0	4	59.9	69.6	−9.7	86.1
Red Rustproof:											
Red Rustproof	518–3	11	41.6	49.5	−7.9	84.0	------	------	------	------	------
Do	1815	5	45.1	62.2	−17.1	72.5	4	48.6	69.6	−21.0	69.8
Red Rustproof (Ferguson No. 71)	844	2	45.6	61.5	−15.9	74.1	2	45.6	75.9	−30.3	60.1
Culred	518–189	4	48.0	59.3	−11.3	80.9	4	48.0	69.6	−21.6	69.0
Fulghum:											
Fulghum	708	12	50.2	57.3	−7.1	87.6	4	65.5	69.6	−4.1	94.1
Kanota	839	4	65.9	59.3	+6.6	111.1	4	65.9	69.6	−3.7	94.7
Miscellaneous:											
Aurora	831	12	49.4	57.3	−7.9	86.2	4	54.7	69.6	−14.9	78.6
Custis	2041	4	68.4	59.3	+9.1	115.3	4	68.4	69.6	−1.2	98.3
Navarro (Ferguson Navarro)	966	4	41.0	59.3	−18.3	69.1	4	41.0	69.6	−28.6	58.9
Lee	2042	4	69.6	59.3	+10.3	117.4	------	------	------	------	100.0
Randolph	2275	4	65.3	59.3	+6.0	110.1	4	65.3	69.6	−4.3	93.8
Jackson	2276	4	61.0	59.3	+1.7	102.9	4	61.0	69.6	−8.6	87.6
Winter Turf×Aurora	2277	2	69.7	61.5	+8.2	113.3	2	69.7	75.9	−6.2	91.8
Dwarf Culberson×Fulghum	2278	2	37.3	61.5	−2.2	60.7	2	37.3	75.9	−38.6	49.1
Fulghum×Hatchett	2279	2	56.9	61.5	−4.6	92.5	2	56.9	75.9	−19.0	75.0

Among the Fulghum strains only Fulghum (C. I. No. 708) has been grown for a period of sufficient length to determine relative values. This strain has produced better yields than the Red Rustproof strains, but not such good yields as the leading strains of the other winter-oat types. The Fulghum type of oat, like the Red Rustproof, lacks winter hardiness, being even less hardy than the latter. This results in reduced stands and poor yields except in very favorable years.

Among the miscellaneous oat strains only one, Aurora, has been grown for more than 10 years. This variety, like Fulghum, lacks winter hardiness, and although the kernel type of Aurora is superior, its lack of hardiness often results in poor stands and low yields.

Selections from a cross made by the senior writer in 1915 between Winter Turf (C. I. No. 431) and Aurora (C. I. No. 831) have shown unusual promise. Several strains resulted from this cross, but the strain named Lee is the most promising. The Lee strain has plump, yellow kernels, is about as early in maturing as any of the winter-oat types except Fulghum, has at least as high a degree of hardiness as the more hardy Culberson and Bicknell strains, and yields exceptionally well. A comparison of the results obtained at Arlington Farm in the 4-year period from 1921 to 1925, inclusive, shows that Lee yielded at least 4 bushels more than any of the other promising winter strains except Custis, a selection from the same cross which yielded only 1.2 bushels per acre less than Lee. One other strain from this cross, recently named Randolph, also yielded well, but not significantly better than two strains of Winter Turf, one strain of Bicknell, and two of Fulghum.

Table 3 presents a detailed analysis and comparison of the yielding power of the different varieties grown at Arlington Farm for the 10 and 4 year periods.

In Table 3 are presented comparisons between the yields of all the varieties shown in Table 2 with those of each of two standard varieties, Winter Turf (C. I. No. 431) and Lee (C. I. No. 2042). The average yields of the so-called standard varieties for comparable years are expressed as 100 per cent, the average yields of the varieties compared being more or less than 100 per cent as the case might be.

Few varieties grown for a long period have exceeded the yield of Winter Turf (C. I. No. 431). The two selections from Winter Turf (C. I. No. 435–4 and 541–4) each have outyielded the older strain by some 8 bushels, or 14 per cent. Several varieties grown for short periods also have exceeded this standard. Some of the most promising are Kanota (C. I. No. 839), Custis (C. I. No. 2041), Lee (C. I. No. 2042), Randolph (C. I. No. 2275), and C. I. No. 2277. None of these strains has been grown for more than four years, and the last one for two years only. Lee outyielded the standard Winter Turf by 10.3 bushels (17.4 per cent). Custis, a similar selection, gave a yield of 15.3 per cent greater.

All of the Winter Turf strains surpassed Fulghum (C. I. No. 708) from 7.1 to 13.3 bushels per acre. The result demonstrates the lack of winter hardiness of Fulghum, all of the so-called hardy strains outyielding this variety regardless of the number of years compared. Among the less hardy strains of the Red Rustproof type, however, Fulghum is superior. This probably is due to the early maturity of Fulghum and its ability to withstand hot weather during the heading and ripening periods. This latter characteristic is typical of varieties of *Avena byzantina*, to which the Red Rustproof and Fulghum strains belong.

In comparing the various varieties with Lee, none was its equal. (Fig. 7.) The nearest approach to the yield of Lee was made by Custis, a strain of similar origin. Lee has been grown for only four years, so that further trial may show some variation from this superiority, but from present data Lee is more promising than any other variety so far grown at Arlington Farm. Lee apparently possesses sufficient hardiness to resist to a high degree even the most rigorous winter conditions usually experienced at Arlington, varieties with less hardiness failing almost completely to survive. The variety is considerably earlier than Winter Turf, and its kernel characters are of as high a degree of excellence as are possessed by any winter oat. Lee is the most promising new variety now available for fall seeding in the northern part of the fall-sown oat section, embracing Maryland, Virginia, North Carolina, and Tennessee, and possibly Arkansas and southern Kentucky.

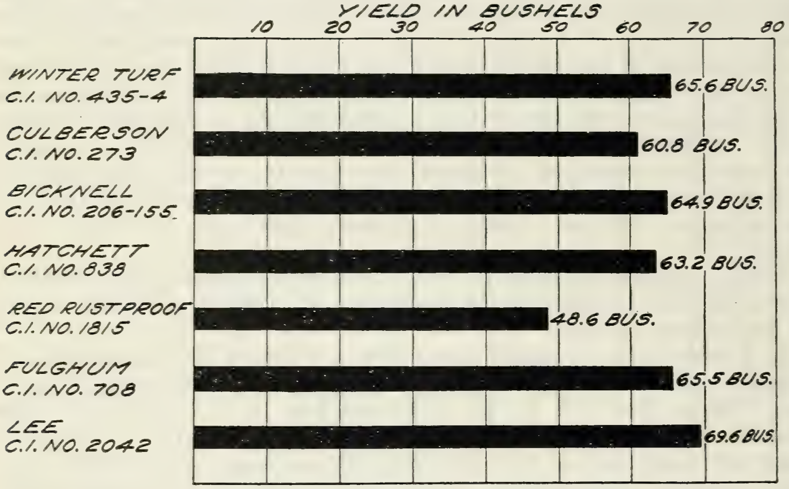

FIG. 7.—Average acre yields of leading strains of fall-sown oats in each of seven varietal groups grown in field plots at the Arlington Experiment Farm during the five-year period from 1921 to 1925, inclusive

NURSERY EXPERIMENTS

In addition to the varietal experiments in field plots, numerous varieties and strains of fall-sown oats have been grown in nursery experiments at the Arlington Experiment Farm for the determination of their adaptation and relative yield. The first nursery was sown in the fall of 1907. Since that date nursery plantings have been made every year except in the fall of 1912. Owing to severe winterkilling followed by a cold dry spring and an unusually heavy growth of weeds, the nursery of 1920 was abandoned. In a few other years many of the varieties and strains grown in nursery rows were badly injured or completely destroyed by winterkilling. The most unfavorable years for nursery plantings were 1915, 1916, 1918, and 1920.

In later years many hybrid selections have been included in the nursery experiments. Older strains which could not compete with the new high-yielding sorts were discontinued. Altogether, hundreds of different strains have been grown in the nursery experiments. However, only a relatively small number of all these strains have been of sufficient promise to warrant their continuance over a period of years.

NURSERY METHODS

Prior to 1913 only single or duplicate rod rows of each strain were grown. These tests were largely preliminary, and the data obtained are not presented in this bulletin. Beginning with 1913 and continuing up to and including 1920, most strains were grown in triplicated single-rod rows, with every tenth row sown to the Culberson variety as a check. Since 1921 the best of the different varieties and selections grown in the oat nursery have been sown in duplicated three-row blocks or plots. Check plots are no longer used. When sown the rows are 18 feet in length, but at harvest they are reduced to 15 feet by discarding 1½ feet from each end. Approximately 100 strains are grown in the duplicated three-row block nursery each year (*8*).

The average yields obtained during the eight-year period from 1913 to 1920, inclusive, together with the annual and average yields obtained during the five-year period from 1921 to 1925, inclusive, from a number of varieties and selections of fall-sown oats grown in nursery rows and plots at the Arlington Experiment Farm are given in Table 4.

TABLE 4.—*Annual acre yields of fall-sown oat varieties and selections grown in nursery rows at Arlington Experiment Farm during two or more years for the five-year period from 1921 to 1925, inclusive, together with average yields for other periods stated*

Group and variety	C. I. No.	Acre yields (bushels)									Percentage of—	
		Average for 1913 to 1920[1]	1921	1922	1923	1924	1925	Average			Winter Turf (C. I. No. 435-1513), 1921 to 1925	Winter Turf (C. I. No. 435-4), 1923 to 1925
								1921 to 1925	1923 to 1925	1924 and 1925		
Winter Turf:												
Winter Turf	435-1513	[2] 52.6	87.0	70.0	78.9	49.4	72.5	71.6	66.9	61.0	100.0	99.9
Do	409-5	53.4	81.8	78.8	67.7	45.0	73.9	69.4	62.2	59.5	96.9	92.8
Do	435-4	50.8	70.2	68.5	77.0	48.3	75.6	67.9	67.0	62.0	94.8	100.0
Do	541-4	57.0	76.2	63.8	74.7	44.1	72.6	66.3	63.8	58.4	92.6	95.2
Do	541	57.1	82.1	64.7	75.0	44.3	63.4	65.9	60.9	53.9	92.0	90.9
Do	166	44.7	68.9	67.0	74.3	44.5	73.1	65.6	64.0	58.8	91.6	95.5
Do	435	49.6	66.3	68.9	69.4	50.9	71.6	65.4	64.0	61.3	91.3	95.5
Do	203-5	51.1	74.9	63.4	71.0	39.1	77.7	65.2	62.6	58.4	91.1	93.4
Do	274-20	49.1	69.5	64.4	65.5	43.9	76.6	64.0	62.0	60.3	89.4	92.5
Culberson:												
Culberson	273-35	48.1	63.1	78.9	67.9	52.6	83.2	69.1	67.9	67.9	96.5	101.3
Do	201	51.4	57.2	87.0	65.5	50.3	78.0	67.6	64.6	64.2	94.4	96.4
Dwarf Culberson	748	42.9	68.4	100.2	58.7	34.5	65.2	65.4	52.8	49.9	91.3	78.8
Culberson	273-41-1	[3] 47.9	66.0	83.7	69.6	45.8	67.6	66.5	61.0	56.7	92.9	91.0
Do	273-60	54.2	58.4	83.4	66.1	45.3	68.1	64.3	59.8	56.7	89.8	89.3
Do	273	42.0	66.4	85.3	54.3	43.9	64.5	62.9	54.2	54.2	87.8	80.9
Do	273-1517	[2] 36.4	54.8	85.6	60.9	37.0	64.3	60.5	54.1	50.7	84.5	80.7
Do	273-41-203	------	----	-----	59.7	36.2	76.6	----	57.5	56.4	--------	85.8
Bicknell:												
Bicknell	206-155	[4] 42.6	70.5	81.4	58.1	67.4	60.3	67.5	61.9	63.9	94.3	92.4
Hatchett:												
Tech (Hutcheson selection)	947	------	73.7	100.8	58.5	52.9	69.1	71.0	60.2	61.0	99.2	89.9
Hatchett	206-1513	------	78.6	88.6	59.6	40.1	66.8	66.7	55.5	53.5	93.2	82.8
Tech	691	------	78.1	87.9	66.8	41.3	56.5	66.1	54.9	48.9	92.3	81.9
Hatchett	838	------	70.2	89.8	70.7	39.0	59.2	65.8	56.3	49.1	91.9	84.0
Edgecomb	933	------	----	95.2	52.7	56.0	68.0	----	58.9	62.0	--------	87.9

[1] The lower average yields for the period from 1913 to 1920, inclusive, in part at least were due to severe injury by winterkilling in 1915 and 1920.

[2] Average for the period from 1917 to 1920, inclusive.

[3] Average for the period from 1915 to 1920, inclusive.

[4] Yields for the original Bicknell (C. I. No. 206) used for the years 1913 to 1916, inclusive.

TABLE 4.—*Annual acre yields of fall-sown oat varieties and selections grown in nursery rows at Arlington Experiment Farm during two or more years for the five-year period from 1921 to 1925, inclusive, together with average yields for other periods stated*—Continued

Group and variety	C. I. No.	Acre yields (bushels)									Percentage of—	
		Average for 1913 to 1920	1921	1922	1923	1924	1925	Average			Winter Turf (C. I. No. 435–1513), 1921 to 1925	Winter Turf (C. I. No. 435–4), 1923 to 1925
								1921 to 1925	1923 to 1925	1924 and 1925		
Red Rustproof:												
Red Rustproof	518–5	27.3	49.8	68.4	75.8	48.8	67.9	62.1	64.2	58.4	86.7	95.8
Do	512	20.5	52.4	77.2	65.5	43.8	53.0	58.4	54.1	48.4	81.6	80.7
Do	775	------	42.3	79.1	71.5	43.3	57.0	58.6	57.3	50.2	81.8	85.5
Do	844	------	40.8	77.0	65.4	44.7	62.6	58.1	57.6	53.7	81.1	86.0
Do	1571	------	----	66.2	52.1	38.9	54.8	----	48.6	46.9	--------	72.5
Culred	581 a1–7–3	------	75.4	88.2	89.6	50.5	75.0	75.7	71.7	62.8	105.7	107.0
Do	518–189	------	72.2	86.8	82.8	53.1	82.7	75.5	72.9	67.9	105.4	108.8
Fulghum:												
Fulghum	708	30.2	44.0	86.1	79.9	64.4	77.0	70.3	73.8	70.7	98.2	110.1
Kanota	839	------	44.1	87.8	78.6	56.7	75.2	68.5	70.2	66.0	95.7	104.8
King	850	------	----	76.9	80.6	51.4	74.2	----	68.7	62.8	--------	102.5
Alabama Hybrid No. 651	971	------	----	-----	----	55.7	74.3	----	----	65.0	--------	--------
Fulghum [5]	699–2011	------	----	-----	79.3	63.3	92.3	----	78.3	77.8	--------	116.9
Do.[5]	699–202	------	----	-----	74.1	56.5	87.1	----	72.6	71.8	--------	108.4
Do.[5]	699–209	------	----	-----	72.7	62.9	79.2	----	71.6	71.1	--------	106.9
Do.[5]	699–2015	------	----	-----	72.7	51.6	89.2	----	71.2	70.4	--------	106.3
Do.[5]	708–204	------	----	-----	67.0	52.7	86.0	----	68.6	69.4	--------	102.4
Do.[5]	650–203	------	----	-----	69.5	57.1	79.3	----	68.6	68.2	--------	102.4
Miscellaneous:												
Aurora	831	29.0	65.7	83.4	56.3	55.0	45.9	61.3	52.4	50.5	85.6	78.2
Yellow Peruvian	975	------	55.1	90.1	58.5	58.5	44.3	61.3	53.8	51.4	85.6	80.3
Navarro (Ferguson Navarro)	966	------	47.6	72.2	57.3	32.5	33.6	48.6	41.1	33.1	67.9	61.3
Hybrids:												
Winter Turf×Aurora—												
Lee (1001 f1–1B)	2042	------	73.0	84.4	65.7	47.7	88.0	71.8	67.1	67.9	100.3	100.1
Custis (1001 d1–1B)	2041	------	57.6	80.4	62.3	46.4	80.7	65.5	63.1	63.6	91.5	94.2
1001 h1–4–5B	----------	------	----	75.4	63.3	53.0	92.1	----	69.5	72.6	--------	103.7
1001 d1–4–3B	2277	------	----	77.2	58.1	44.7	77.3	----	60.0	61.0	--------	89.6
1005 a4–18B	----------	------	----	77.8	50.8	32.2	59.1	----	47.4	45.7	--------	70.7
Winter Turf×Sixty-Day—												
1009 b2–53B	2289	------	----	68.4	50.5	49.2	52.6	----	50.8	50.9	--------	75.8
Aurora×Fulghum—												
1006 b1–20B1	----------	------	----	-----	69.4	41.4	53.6	----	54.8	47.5	--------	81.8
1006 b1–20B2	----------	------	----	-----	67.0	47.7	55.7	----	56.8	51.7	--------	84.8
Red Rustproof×Daubeney—												
1039 a1–21	----------	------	----	-----	62.4	36.2	54.8	----	51.1	45.5	--------	76.3
Dwarf Culberson×Fulghum—												
1047 a1–39	2291	------	----	-----	----	52.7	88.7	----	----	70.7	--------	--------
1047 b1–20	----------	------	----	-----	----	58.6	72.7	----	----	65.7	--------	--------
1047 b1–132	----------	------	----	-----	----	60.2	68.9	----	----	64.6	--------	--------
1047 b1–137	----------	------	----	-----	----	62.3	66.7	----	----	64.5	--------	--------
1047 b2–8	----------	------	----	-----	----	59.4	64.2	----	----	61.8	--------	--------
Culberson×Fulghum—												
1049 b1–15	----------	------	----	-----	----	38.5	62.9	----	----	50.7	--------	--------
1049 b1–28	----------	------	----	-----	----	49.7	42.5	----	----	46.1	--------	--------
Fulghum×Hatchett—												
1050 a4–1	----------	------	----	-----	----	42.1	83.6	----	----	62.9	--------	--------
1050 a2–2	----------	------	----	-----	----	55.3	60.3	----	----	57.8	--------	--------
1050 a2–6	----------	------	----	-----	----	46.5	67.8	----	----	57.2	--------	--------
1050 a3–18	----------	------	----	-----	----	57.3	54.6	----	----	56.0	--------	--------
1050 b2–12	----------	------	----	-----	----	43.9	69.3	----	----	56.6	--------	--------
Aurora×Hatchett—												
1052 a2–3	----------	------	----	-----	----	49.2	49.7	----	----	49.5	--------	--------
1052 a2–6	----------	------	----	-----	----	43.9	68.2	----	----	56.1	--------	--------

[5] Winter forms of Fulghum.

A number of the varieties and selections included in the field-plot experiments were grown also in the nursery. The yields obtained in the nursery from the two Winter Turf selections (C. I. Nos. 435–4 and 541–4) accord with those from plots, indicating that these strains are consistently high yielding. However, another selection of Winter Turf (C. I. No. 435–1513) made by the senior writer in 1915, produced slightly the highest yield of all Winter Turf strains grown in the nursery during the period from 1921 to 1925.

The Culberson strains when grown in the nursery, as in the field plot experiments, were slightly below those of the Winter Turf group in yield. One of the Culberson strains (C. I. No. 273–41–203) is of particular interest, as the young plants are completely covered with short setaceous hairs. This strain seems to possess unusual cold resistance, but so far it has not shown high-yielding ability. The one Bicknell strain for which data are given has about equaled the best Culberson strains in yield.

The Hatchett or black winter strains have produced yields in the nursery considerably higher than in field plots. As a group these strains have about equaled the Winter Turf strains in average yield. The black kernels of these strains are not desirable.

The Red Rustproof strains in the nursery have fallen considerably below those of the three preceding varieties in yield, agreeing with the field-plot results. These strains yield less than the strains of other standard varieties when grown in either field or nursery, yet like the Hatchett strains their nursery yields have been inconsistently higher than in field plots.

The two strains of Culred rank among the very highest yielders in the nursery. This oat differs from the Red Rustproof in having narrower leaves and a more spreading habit in early growth. The kernels of these two strains are a grayish white in color. Culred (Hybrid No. 581 a1–7–3) originated as a selection from a hybrid made about 20 years ago between Red Rustproof and Culberson. The other strain (C. I. No. 518–189) was selected from Red Rustproof (C. I. No. 518) in 1918. This strain is identical morphologically with Culred and probably resulted from natural hybridization. The grain quality of these strains has been rather poor. Culred (C. I. No. 518–189) grown in field plots produced a very unsatisfactory yield, and its excellent nursery yield is difficult to explain.

The original Fulghum strains (C. I. Nos. 708, 839, and 850) gave very high yields under nursery conditions. These strains produced average nursery yields exceeding those of the best Winter Turf strains during the three-year period from 1923 to 1925, inclusive. Under the nursery conditions prevailing at the Arlington Experiment Farm, the tender varieties seem to be more favored than when grown in plots under field conditions. This is indicated by the behavior of the Hatchett, Red Rustproof, and Fulghum strains.

Promising strains of Fulghum have been isolated, as is shown by nursery yields during the years 1923 to 1925, inclusive. These selections represent a distinct winter form of Fulghum. The young plants are a darker green in color and more prostrate in early growth habit, and most of the strains are a little later in maturity than the original Fulghum. There also is considerable variation in size of kernel. These winter forms of Fulghum appear promising as new fall-sown strains for the Fulghum oat area of the South.

The identical varieties Aurora and Yellow Peruvian have not produced high nursery yields. They have about equaled the Red Rustproof strains. The Aurora type of oats is entirely too tender for best results from fall seeding. The variety Navarro (Ferguson Navarro, C. I. No. 966) was obtained from the Ferguson Seed Farms, Sherman, Tex., a few years ago. It is said to have originated as a selection from a field of Red Rustproof oats in Navarro County, Tex. This is a distinct new variety, with a beautiful purple waxy bloom at maturity, but it is not promising as a winter oat. It is highly resistant to or immune from the smuts of oats and may be of value for plant-breeding purposes.

The Lee and Custis strains, selected from the hybrid between Winter Turf and Aurora, have given good nursery yields, although not so promising as those in the field-plot experiments. As previously noted from plot experimental results, the Lee is especially promising for sowing in the northern transitional zone of the fall-sown oat belt. The Aurora-Winter Turf strains, including Lee and Custis, as a group show high yielding ability, in addition to excellent kernel characters.

Of the other hybrids which have been grown in the nursery, none have been tested long enough to warrant any recommendation. The value of most of these strains remains to be determined. However, none seems so promising as those from the cross between Winter Turf and Aurora.

Reverting to the better yields from certain of the more tender varieties in nursery experiments than when grown in plots, several factors operating alone or in combination may be responsible for this result. The nursery rows at Arlington are sown in a decided furrow. The furrow undoubtedly affords the young plants considerable protection against cold winds and heaving. No such furrow is formed on the plots where the seed is sown with a disk drill. The nursery rows are sown 12 inches apart, whereas the distance between drills in the plots is 8 inches. Approximately equal quantities of seed per unit of area are used in the two cases. The greater resultant crowding of the plants in the nursery rows may give some additional protection against injury by cold. Nursery rows run north and south, whereas the plots are drilled from east to west. Prevailing cold winds blow from the northwest, and it is possible that the nursery rows running north and south are a little better protected than the plot rows running east and west.

TABLE 5.—*Average agronomic data for 11 fall-sown oat varieties grown in field plots at Arlington Experiment Farm for the four-year period from 1922 to 1925, inclusive*

Variety[1]	C. I. No.	Date		Plant height	Straw yield per acre	Test weight of grain
		Headed	Ripe			
				Inches	*Pounds*	*Pounds*
Custis	2041	May 28	June 23	44	3,653	34.9
Lee	2042	May 25	June 22	41	3,626	36.1
Winter Turf	541–4	May 31	June 27	43	3,433	31.6
Do	431	June 1	June 28	42	3,366	34.3
Do	435–4	May 31	June 27	43	3,362	31.5
Culberson	273	May 24	June 23	43	3,254	33.0
Bicknell	206–155	May 25	June 22	43	3,195	33.5
Hatchett	838	May 21	June 17	37	2,797	33.1
Dwarf Culberson	748	May 23	do	34	2,684	33.0
Kanota	839	May 20	June 14	40	2,508	32.8
Red Rustproof	1815	May 24	June 21	37	2,269	30.9

[1] The varieties are arranged in the order of their straw yield.

AGRONOMIC DATA FOR IMPORTANT VARIETAL TYPES

Agronomic data other than yield also must be considered in choosing a cereal variety. Average data for date of heading, date of ripening, plant height, straw yield, and test weight of grain of the leading strains for nine of the most important fall-sown oat types grown in plot experiments at the Arlington Experiment Farm during the four years from 1922 to 1925, inclusive, are shown in Table 5.

When grown from fall seeding at the Arlington Experiment Farm, Kanota and Hatchett may be classed as early; Bicknell, Culberson, Custis, Dwarf Culberson, Lee, and Red Rustproof as midseason; and Winter Turf as late. Red Rustproof produced the least and Custis the most straw. In the test weight of grain Lee and Custis are superior to all other sorts. Custis is the tallest variety.

RESULTS AT EXPERIMENT STATIONS IN GEORGIA

During the last 10 years varietal experiments with fall-sown oats have been conducted at Athens, Ashburn, Quitman, and Tifton, Ga. The experiments at Athens were conducted on the experiment station farm of the Georgia State College of Agriculture, located in Clark County, in the Piedmont section of northeastern Georgia. These experiments were conducted cooperatively by the Office of Cereal Crops and Diseases of the Bureau of Plant Industry and the Georgia State College of Agriculture. Childs (*1*) reported on these experiments in 1916. Climatic conditions at Athens probably are less favorable to fall-sown oats than on the Coastal Plain or in southern Georgia primarily because of lower winter temperatures. Soil conditions probably are about equal. At Tifton, Tift County, experiments were conducted on the farms of both the Georgia Coastal Plain Experiment Station and the Agricultural and Mechanical School. At Ashburn, Turner County, and at Quitman, Brooks County, both in southern Georgia, the soils are very sandy, and the harvest is usually early. Fall-sown oats as a rule ripen in early May, and when rust is not too prevalent and the spring season is not too dry, excellent crops are frequently harvested. For this latter section rapid growth and early maturity are essential for the production of high yields of fall-sown oats.

During the eight years 1915, 1916, 1919, 1920, and 1922 to 1925, inclusive, 15 varieties and selections of fall-sown oats were grown in the experiments conducted at Athens. At the Coastal Plain Experiment Station, Tifton, 14 varieties and selections were grown for two or more years during the period from 1920 to 1925, inclusive. At the Agricultural and Mechanical School, Tifton, 10 varieties and selections were grown during the years 1917 to 1919, inclusive. On the farm of J. S. Shingler, at Ashburn, 11 varieties were grown in 1915 and 1916. On the county farm at Quitman the same 11 varieties were grown during the years 1915 to 1917, inclusive. At Athens the varieties usually were sown after corn and in duplicated hundredth-acre plots. At Ashburn, Tifton, and Quitman, duplicated fiftieth-acre plots were used, one plot after corn and one plot after cotton. The annual and average yields obtained from the varieties grown in these experiments are given in Tables 6 to 9, inclusive.

TABLE 6.—*Yields of fall-sown oat varieties grown at the Georgia State College of Agriculture, Athens, Ga., during two or more years from 1915 to 1925, inclusive*

[The 1921 crop was destroyed by fire]

Group and variety	Georgia station No.	Acre yields (bushels)												
												Average		
		1915	1916	1917	1918	1919	1920	1922	1923	1924	1925	1915 to 1920 and 1922 to 1925	1924 and 1925	1915 to 1920 and 1922 and 1923
Red Rustproof:														
Hasting (Hundred Bushel)	325–1	67.9	71.1	0	0	56.2	62.7	69.3	78.5	10.8	70.8	48.7	40.8	50.7
Bancroft	225–19	53.3	64.1	0	2.3	62.5	62.9	69.2	81.5	14.4	69.9	48.0	42.2	49.5
Coker Appler	400–48	67.7	67.9	0	0	43.6	57.4	64.3	80.9	18.1	68.8	46.9	43.5	47.7
Appler	200–10	65.6	63.3	0	9.0	50.0	56.8	62.6	60.0	10.5	68.5	44.6	39.5	45.9
Texas Red Rustproof	250–11	64.4	69.5	0	8.2	40.6	35.0	62.9	76.7	6.6	62.5	42.6	34.6	44.7
Patterson	----	----	----	----	----	----	----	52.5	77.4	11.2	71.1	----	41.2	----
Fulghum:														
Fulghum	100–5	55.0	75.7	0	7.0	71.8	51.9	74.6	61.0	7.7	67.8	47.3	37.8	49.6
Burt:														
Burt	125–6	47.0	46.1	0	0	0	39.4	63.8	52.6	9.6	47.3	30.6	28.5	31.1
Early Ripe	150–1	42.2	44.9	0	0	0	37.7	----	60.6	6.4	----	----	----	----
	C. I. No.													
Winter Turf:														
Winter Turf	435–4	43.3	12.5	0	47.3	55.0	40.4	3.5	28.7	14.6	49.3	29.5	32.0	28.8
Culberson:														
Culberson (selection)	----	57.4	46.9	4.0	6.6	63.0	39.2	9.8	50.1	----	----	----	----	34.6
Culberson	273	48.8	44.5	16.8	21.9	50.0	41.0	17.5	41.7	----	----	----	----	35.3
Bicknell:														
Bicknell	206	50.0	42.2	4.3	17.2	63.0	41.0	8.2	----	----	----	----	----	----
Hatchett:														
Black Winter	----	65.6	53.9	0	0	46.8	32.6	----	----	----	----	----	----	----
Miscellaneous:														
Lee	2042	----	----	----	----	----	----	----	----	41.8	59.2	----	50.5	----
Custis	2041	----	----	----	----	----	----	----	----	38.9	54.9	----	46.9	----

TABLE 7.—*Yields of fall-sown oat varieties grown at the Coastal Plain Experiment Station, Tifton, Ga., from 1920 to 1925, inclusive*

Group and variety	Georgia station No.	C. I. No.	Acre yields (bushels)									
									Average			
			1920	1921	1922	1923	1924	1925	1920 to 1925	1921 to 1925	1920 to 1923	1923 to 1925
Red Rustproof:												
Hasting (Hundred Bushel)	----	325–1	44.3	62.5	31.1	27.3	50.0	36.2	41.9	41.4	41.3	37.8
Coker Appler	----	400–18	47.4	57.9	26.4	12.4	47.9	38.4	38.4	36.6	36.0	32.9
Appler	200–10	----	47.2	55.2	24.1	22.4	43.7	32.4	37.5	35.6	37.2	32.8
Bancroft	225–19	----	45.1	49.9	27.6	12.3	49.2	38.2	37.1	35.4	33.7	33.2
Patterson	----	----	----	59.7	32.8	16.0	42.9	29.9	----	36.3	----	29.6
Texas Red Rustproof	250–11	----	22.1	39.9	26.5	23.1	48.0	31.7	31.9	33.8	27.9	34.3
Fulghum:												
Fulghum	100–5	----	34.7	54.9	42.1	16.1	30.7	29.9	34.7	34.7	37.0	25.6
Kanota	----	839	----	----	----	12.6	17.9	25.5	----	----	----	18.7
Burt:												
Burt	125–6	----	----	43.8	24.1	7.5	38.6	19.1	----	26.6	----	21.7
Early Ripe	150–21	----	27.1	34.5	25.1	8.3	37.6	15.5	24.7	24.2	23.8	20.5
Culberson:												
Culberson	----	273	22.8	15.3	11.9	1.4	----	----	----	----	12.9	----
Culberson selection	----	----	18.7	17.3	12.7	.3	----	----	----	----	12.3	----
Winter Turf:												
Winter Turf	----	435–4	5.1	12.9	----	----	----	----	----	----	----	----
Miscellaneous:												
Navarro (Ferguson Navarro)	----	966	----	----	----	7.0	15.3	14.2	----	----	----	12.2

Most of the varieties grown in these experiments were pure-line selections. These were developed by selecting several hundred panicles from each variety. The seed from every head or panicle was sown in a separate row and threshed separately. The poorer strains were gradually eliminated from year to year in nursery tests until only the selection giving the highest average yield remained. This was multiplied and used for general seeding.

At the Georgia State College of Agriculture the Hasting (Hundred Bushel) strain of Red Rustproof, which originated as a selection from Appler, another strain of Red Rustproof, gave the highest yield, with Bancroft a close second. (Table 6.) These were followed in order by Fulghum, Coker Appler, Appler, and Texas Red Rustproof—all except Fulghum being strains of Red Rustproof.

The Fulghum variety, while producing the third highest average yield, is more subject to seasonal variations than Appler, for instance. Fulghum produces very high yields in favorable years, but drops low in unfavorable years. The variety is extremely susceptible to leaf rust, which often reduces the yield. Burt and Early Ripe are not sufficiently hardy for successful culture from fall seeding even in the South. Such varieties as Culberson, Hatchett, and Winter Turf are not well adapted to conditions in Georgia. The Lee and Custis varieties have produced fair yields during the two years they have been grown, but because of their winter hardiness these varieties are considered better adapted to the extreme northern part of the Cotton Belt.

TABLE 8.—*Yields of fall-sown oat varieties grown at the Agricultural and Mechanical School, Tifton, Ga., from 1917 to 1919, inclusive*

Group and variety	Georgia station No.	C. I. No.	Acre yields (bushels)				
			1917	1918	1919	Average	
						1917 to 1919	1918 to 1919
Red Rustproof:							
Hasting (Hundred Bushel)		325–1	37.1	36.7	5.4	26.4	21.1
Appler	200–10		40.6	39.0	2.8	27.5	20.9
Bancroft	225–19		34.3	36.3	5.9	25.5	21.1
Texas Red Rustproof	250–11		29.3	40.8	4.1	24.7	22.5
Coker Appler		400–18	26.9	35.7	2.7	21.8	19.2
Fulghum:							
Fulghum	100–5		27.3	35.7	4.7	22.6	20.2
Burt:							
Early Ripe	150–21			28.9	4.5		16.7
Burt	125–6			29.7	3.5		16.6
Culberson:							
Culberson		273	8.1	35.2	6.3	16.5	20.8
Bicknell:							
Bicknell			2.3	34.8	4.3	13.8	19.6

Many growers find it profitable when fairly large acreages are grown to sow Red Rustproof on part of the area and Fulghum on the remainder. The Fulghum ripens from 7 to 14 days earlier than the Red Rustproof. This simplifies the harvesting problem by distributing the optimum time for cutting over a longer period. A field of Red Rustproof oats near Columbia, S. C., is shown in Figure 8.

In the experiments at the Coastal Plain Experiment Station, Tifton, Ga., the Red Rustproof strains, Hasting (Hundred Bushel), Appler, Coker Appler, Bancroft, and Patterson, have all given slightly higher yields than Fulghum and appear to be somewhat better for that section. (Table 7.) This advantage is probably due to their greater resistance to leaf rust as compared with Fulghum.

The experiments at the South Georgia Agricultural and Mechanical College, Tifton, Ga., gave similar results. (Table 8.)

The experiments at Ashburn and Quitman (Table 9), although covering shorter periods, show that such strains of Red Rustproof as Appler, Hasting (Hundred Bushel), and Bancroft are all high yielders. The Fulghum variety also yields equally well in that section.

A detailed analysis and comparison of the yields of the varieties and strains grown at Athens and Tifton are shown in Table 10.

TABLE 9.—*Yields of fall-sown oat varieties grown on the farm of J. S. Shingler, Ashburn, Ga., and at the county farm, Quitman, Ga., from 1915 to 1917, inclusive*

Locality, group, and variety	Acre yields (bushels)		
	1915	1916	Average, 1915 and 1916
ASHBURN, GA.			
Red Rustproof:			
Appler	39.8	36.0	37.9
Hasting (Hundred Bushel)	31.5	41.3	36.4
Texas Red Rustproof	33.6	37.1	35.4
Bancroft	33.7	34.3	34.0
Fulghum:			
Fulghum	48.4	53.2	50.8
Burt:			
Burt	44.5	52.2	48.4
Early Ripe	37.9	48.4	43.2
Culberson:			
Culberson	33.6	20.3	27.0
Bicknell:			
Bicknell	17.6	20.3	19.0
Winter Turf:			
Winter Turf	22.6	6.2	14.4
Hatchett:			
Black Winter	29.7	31.2	30.5

Locality, group, and variety	Acre yields (bushels)				
	1915	1916	1917	Average	
				1915 to 1917	1915 and 1916
QUITMAN, GA.					
Red Rustproof:					
Hasting (Hundred Bushel)	26.9	37.5	6.6	23.7	32.2
Appler	22.6	30.4	7.0	20.0	26.5
Texas Red Rustproof	19.7	34.7	5.5	20.0	27.2
Bancroft	19.3	33.5	3.0	18.6	26.4
Fulghum:					
Fulghum	17.4	32.4	18.7	22.8	24.9
Burt:					
Early Ripe	26.0	27.3	3.0	18.8	26.7
Burt	10.4	27.3	3.1	13.6	18.9
Culberson:					
Culberson	21.9	26.1	0	16.0	24.0
Bicknell:					
Bicknell	12.2	21.0	0	11.1	16.6
Winter Turf:					
Winter Turf	11.3	12.9			12.1
Hatchett:					
Black Winter	23.2	25.4	0	16.2	24.3

The analyses of the yields obtained at Athens and at Tifton indicate that there are distinct differences in the yielding powers of the various named strains of the Red Rustproof oat. At both stations Hasting

(Hundred Bushel) ranks first in yield. Bancroft and Coker Appler rank second in yield at Athens and Tifton, respectively. The Fulghum variety produced 97.1 per cent of the yield of the Hasting at Athens, while at Tifton it produced only 82.8 per cent of the yield of that strain. This result probably is due to the greater prevalence of leaf rust at Tifton. Burt (Early Ripe) produced 62.8 and 58.9 per cent of the yield of Hasting at Athens and at Tifton, respectively. In Georgia, Winter Turf was inferior to all other varieties, yielding only 60.6 per cent at Athens as compared to 100 per cent for Hasting and 97.1 per cent for Fulghum.

Fig. 8.—A field of excellent fall-sown Red Rustproof oats near Columbia, S. C.

Table 10.—*Comparison of average acre yields of varieties of fall-sown oats with Hasting and Fulghum for comparable years at Athens and Tifton, Ga.*

Locality and variety or strain	Total years grown for which comparable data are available	Average annual yield[1] (bushels)	Comparison with Hasting, same years		Comparison with Fulghum, same years	
			Deviation from Hasting (bushels)	Percentage of yield of Hasting	Deviation from yield of Fulghum (bushels)	Percentage of yield of Fulghum
State College of Agriculture, Athens:						
Hasting (Hundred Bushel)	10	48.7	0	100.0	+1.4	103.0
Bancroft	10	48.0	−.7	98.6	+.7	101.5
Fulghum	10	47.3	−1.4	97.1	0	100.0
Coker Appler	10	46.9	−1.8	96.3	+.4	99.2
Appler	10	44.6	−4.1	91.6	−2.7	94.3
Texas Red Rustproof	10	42.6	−6.1	87.5	−4.7	90.1
Burt	10	30.6	−18.1	62.8	−16.7	64.7
Winter Turf	10	29.5	−19.2	60.6	−17.8	62.4
Coastal Plain Experiment Station, Tifton:						
Hasting (Hundred Bushel)	6	41.9	0	100.0	+7.2	120.7
Coker Appler	6	38.4	−3.5	91.6	+3.7	110.7
Appler	6	37.5	−4.4	89.5	+2.8	108.1
Bancroft	6	37.1	−4.8	88.5	+2.4	106.9
Fulghum	6	34.7	−7.2	82.8	0	100.0
Texas Red Rustproof	6	31.9	−10.0	76.1	−2.8	91.9
Early Ripe	6	24.7	−17.2	58.9	−10.0	71.2

[1] Varieties and strains appear for each station in the order of their average yields.

RESULTS AT OTHER SOUTHERN STATIONS

Averages of such yield data as are available from agricultural experiment stations in other Southern States for the three principal varietal types of fall-sown oats, together with similar averages of the data included in this bulletin, are given in Table 11.

The data of Table 11 indicate the superiority of the Red Rustproof and Fulghum varieties for growing in the more southern States. Between the strains of these varieties, where the experiments have been of sufficient duration to be conclusive, there apparently is little choice. Where Fulghum equals Red Rustproof in yield it frequently is preferable because of its earlier maturity. The results in Virginia and Arkansas show that the Winter Turf or others of the more hardy varieties are the most successful in these sections. In the northern or transitional zone of the winter-oat belt it is evident that the Winter Turf is to be recommended above all others.

TABLE 11.—*Yields of the highest yielding strains of Winter Turf, Red Rustproof, and Fulghum oats grown from fall seeding during periods varying from 1 to 12 years at nine experiment stations in six Southern States*

Location of experiment	Number of years conducted	Years in which data were obtained	Average acre yields (bushels)			Acre yields expressed in percentages of Fulghum for each station	
			Winter Turf	Red Rustproof[1]	Fulghum	Winter Turf	Red Rustproof
Virginia:							
Arlington Farm	12	1914 to 1925	57.3	[2] 44.9	[3] 50.2	114.1	89.4
North Carolina:[4]							
Statesville	1	1914	15.4	29.6	34.8	44.3	85.1
Georgia:							
Athens	10	1915 to 1925 [5]	29.5	42.6	47.3	62.4	90.1
Auburn	2	1915 and 1916	14.4	37.9	50.8	28.3	74.6
Quitman	3	1915 to 1917	[6] 12.1	23.7	22.8	53.1	103.9
Tifton [7]	9	1917 to 1925	--------	[8] 41.8	30.7	--------	136.2
Alabama:[9]							
Auburn	2	1912 and 1913	--------	37.9	20.6	--------	184.0
Mississippi:[10]							
Agricultural and Mechanical College	3	1911, 1912, and 1914	36.1	43.3	36.2	99.7	119.6
Arkansas:[11]							
Fayetteville	4	1916 to 1919	35.2	30.7	14.7	239.5	208.8

[1] The highest average yield in some instances was not made by Red Rustproof as such, but by a named strain of it, such as Appler, Cook, Hasting, or Bancroft.

[2] Composite record made up from yields of two strains.

[3] Nursery yield substituted in 1925, no plat data available.

[4] Garren (*3*).

[5] Entire crop destroyed by fire in 1921. No yields available in that year.

[6] Two-year average.

[7] Combined record yields from Agricultural and Mechanical College in 1917, 1918, and 1919 and from Coastal Plain Experiment Station, but a short distance away, in other years.

[8] Hasting rather than Red Rustproof.

[9] Duggar and Cauthen (*2*).

[10] Ricks (*5*).

[11] Nelson and Osborn (*4*).

CULTURAL EXPERIMENTS IN GEORGIA

Limited cultural experiments with fall-sown oats have been conducted in Georgia by the Georgia State College of Agriculture in cooperation with the Office of Cereal Crops and Diseases. These experiments have included date and rate of seeding, method of seeding and seed-bed preparation, place in rotation, and fertilizer experiments. The data from some of these experiments are rather meager, yet they are indicative and in the absence of more comprehensive data should be presented.

Table 12.—*Yields of fall-sown oats in date-of-seeding experiments conducted at five different stations and farms in Georgia during three or more years in the period from 1915 to 1925, inclusive*

Locality and variety	Date of seeding	Acre yields (bushels)																		
		1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	Average							
													1915 to 1925	1915 and 1916	1921 to 1925	1922 to 1925	1921 and 1923	1917 to 1919	1915 to 1917
State College of Agriculture, Athens:																			
Red Rustproof (Appler)	Oct. 15	40.2	33.5	[1]0	20.3	24.4	58.1	49.4	60.5	80.9	[1]0	68.4	39.6						
Do	Nov. 15	31.6	17.1	[1]0	6.3	8.0	20.5	23.0	23.2	30.0	[1]0	48.7	18.9						
Fulghum	Oct. 15	34.2	46.9	[1]0	6.6	20.0	73.4	44.7	97.5	54.8	[1]0	64.6	40.2						
Do	Nov. 15	22.1	26.2	[1]0	1.6	5.2	19.5	31.9	22.3	32.8	[1]0	36.8	18.0						
Farm of J. S. Shingler, Ashburn:																			
Red Rustproof (Appler)	Nov. 1	24.9	38.7											31.8					
Do	Dec. 1	20.7	15.3											18.0					
Fulghum	Oct. 1	30.0	47.8											38.9					
Do	Dec. 1	27.2	20.8											24.0					
Coastal Plain Experiment Station, Tifton:																			
Red Rustproof (Appler)	Oct. 15								36.9	20.4	36.3	43.1				34.2			
Do	Nov. 1							49.1	29.3	26.3	21.4	36.9			32.6	28.5	37.7		
Do	Nov. 15								25.9	19.5	7.5	23.4				19.1			
Do	Dec. 1							38.8	14.7	18.7	4.7	16.7			18.7	13.7	28.8		
Do	Jan. 1							39.3		0							19.7		
Do	Feb. 1							22.8		0							11.4		
Fulghum	Oct. 15								27.0	9.1	27.4	27.1				22.7			
Do	Nov. 1							49.1	22.3	15.8	24.0	27.1			27.7	22.3	32.5		
Do	Nov. 15								22.9	11.9	18.7	22.0				18.9			
Do	Dec. 1							36.8	13.9	5.9	14.8	19.4			18.2	13.5	21.4		
Do	Jan. 1							30.7		0							15.4		
Do	Feb. 1							18.7		0							9.4		
Agricultural and Mechanical School, Tifton:																			
Red Rustproof (Appler)	Nov. 1			25.6	39.3	26.9												30.6	
Do	Dec. 1			13.2	35.9	19.5												22.9	
Fulghum	Nov. 1			42.2	34.7	18.7												31.9	
Do	Dec. 1			26.9	31.6	19.1												25.9	
County farm, Quitman:																			
Red Rustproof (Appler)	Nov. 1	17.5	34.2	10.2															20.6
Do	Dec. 1	15.3	28.7	3.7															15.9
Fulghum	Nov. 1	16.5	32.5	23.4															24.1
Do	Dec. 1	13.1	32.0	20.3															21.8

[1] Completely winterkilled.

DATE OF SEEDING

Fall-sown oats may be sown in many districts of the South at any time from October 1 to January 1. The determination of the optimum date, therefore, is of considerable importance. Date-of-seeding experiments with fall-sown oats were conducted during the period from 1915 to 1925 at the Georgia State College of Agriculture, Athens; from 1921 to 1925 at the Georgia Coastal Plain Experiment Station, Tifton; from 1917 to 1919 at the Agricultural and Mechanical School, Tifton; and from 1915 to 1917 at the county farm, Quitman. The annual and average yields obtained from these experiments are given in Table 12.

From the data in Table 12 it is apparent that late sowing is one of the factors most responsible for the low yield of fall-sown oats in Georgia. This is especially true for the northern part of the State. The 10-year average yields of two varieties of oats sown at Athens on October 15 and November 15, respectively, have been more than doubled by seeding at the earlier date. From October 10 to 18 seems to be the best period for seeding at Athens, with somewhat earlier dates farther north.

The data for the southern part of the State show that seeding in that section may be delayed to November 1 without affecting yield in most years, but that on the average it is advisable to sow earlier even there.

In 1921 and 1923 at the Coastal Plain Experiment Station, Tifton, Ga., seedings were made on January 1 and February 1. Fair yields were obtained in 1921, but a total failure resulted in 1923.

Oats grown from early seeding are plumper and usually have a test weight from 1 to 4 pounds greater than late-sown oats.

A comparison of the yields from the two varieties, especially those from Ashburn, Tifton, and Quitman, indicates that Fulghum is a better variety for late seeding than Red Rustproof (Appler). This probably is explained in part by the earlier maturity of Fulghum.

RATE OF SEEDING

Experiments to determine the best rate to sow winter oats in Georgia have been conducted at Athens since 1916 and at Tifton since 1922. No rate-of-seeding experiments of winter oats were made at Tifton in 1924. At Athens two varieties were grown in these experiments, Red Rustproof (Appler) and Fulghum, although Fulghum was not included until 1918. At Tifton only the Fulghum was grown. The annual and average yields and the deviations from the net yield at the 3-peck rate obtained from these experiments are shown in Table 13.

The average yields obtained from plots of Red Rustproof (Appler) sown at the rate of 3, 4, 6, 8, and 10 pecks per acre, respectively, showed little variation between the different net yields, that is, after deducting the quantity of seed sown. The seasonal variations show unmistakably, however, that the heavier rates were more consistent than the lighter seedings. The highest yielding rate was 6 pecks per acre, which gave a greater gross yield of 5.1 bushels, or a net yield of 4.37 bushels more than the 3-peck rate. The yields at the 8-peck and 10-peck rates were 2.2 and 2.6 bushels, respectively, more than at the 3-peck rate, or considerably less than at the 6-peck rate.

Table 13.—*Acre yields and deviations from yields at the 3-peck rate in rate-of-seeding experiments with fall-sown oats, at two stations in Georgia during two or more years of the 10-year period from 1916 to 1925, inclusive*

[Complete winterkilling of Red Rustproof occurred at Athens in 1917 and of both Red Rustproof and Fulghum in 1924, but the zero yields of 1924 are included in the computation of the averages for 1918 to 1925]

Locality and variety	Rate of seeding (pecks)	Acre yields (bushels)												Deviations from yield at 3-peck rate	
		1916	1918	1919	1920	1921	1922	1923	1924	1925	Average: 1918 to 1925	Average: 1922, 1923, and 1925	Net yield	Net basis	Average basis
State College of Agriculture, Athens:															
Red Rustproof	3	38.3	5.0	6.6	61.1	59.4	57.2	62.9	0	57.5	38.71	------	37.96	0	------
Do	4	40.7	5.4	8.9	57.1	60.0	60.0	62.0	0	59.2	39.08	------	38.08	+.12	+.37
Do	6	45.7	15.9	16.4	68.5	63.1	64.6	62.6	0	59.5	43.83	------	42.33	+4.37	+5.12
Do	8	43.4	18.7	18.9	57.6	61.1	53.1	59.6	0	58.2	40.90	------	38.90	+.94	+2.19
Do	10	40.5	23.5	18.8	65.6	60.8	48.7	54.8	0	58.4	41.33	------	38.83	+.87	+2.62
Fulghum	3	----	1.2	8.7	46.1	38.9	60.6	29.0	0	57.0	30.19	------	29.44	0	------
Do	4	----	1.0	9.8	42.4	35.7	53.5	34.8	0	55.6	29.10	------	28.10	−1.34	−1.09
Do	6	----	3.1	12.7	46.2	37.9	56.3	35.1	0	58.6	31.24	------	29.74	+.30	+1.05
Do	8	----	4.9	12.7	45.3	39.9	64.3	38.2	0	63.2	33.56	------	31.56	+2.12	+3.37
Do	10	----	9.3	13.8	47.8	38.3	67.9	35.6	0	71.2	35.49	------	32.99	+3.55	+5.30
Coastal Plain Experiment Station, Tifton:															
Fulghum	3	----	----	----	----	----	30.4	9.0	----	31.1	------	23.50	22.75	0	------
Do	4	----	----	----	----	----	33.1	11.2	----	28.3	------	24.20	23.20	+.45	+.70
Do	6	----	----	----	----	----	32.4	13.4	----	30.5	------	25.43	23.93	+1.18	+1.93
Do	8	----	----	----	----	----	34.6	11.7	----	32.7	------	26.33	24.33	+1.58	+2.83
Do	10	----	----	----	----	----	36.8	16.2	----	38.1	------	30.37	27.87	+5.12	+6.87

In general, the Fulghum variety sown at the same rates as the Red Rustproof (Appler) produced a regular increase in yield from the lower to the higher rate, except the seedings at the 4-peck rate, which gave lower yields than those at 3 and 6 pecks. A gain of 5.3 bushels over the 3-peck rate resulted from seeding at the rate of 10 pecks. Consequently a seeding rate of 10 pecks per acre for Fulghum appears justified at Athens. It may be that Appler is sufficiently more nearly winter hardy than Fulghum to allow satisfactory stands to be obtained with a lighter seeding rate than is possible with Fulghum.

At the Tifton station Fulghum was sown in a rate-of-seeding experiment conducted in 1922, 1923, and 1925. Fair yields were obtained in 1922 and 1925, but poor yields in 1923. No plots were sown in 1924. The results at Tifton compare closely with those from the rate-of-seeding experiments with Fulghum at Athens. At both stations Fulghum gave its highest yields from the heavy seeding rate of 10 pecks per acre. The increases in yield are more or less progressive with the increase in seeding rate, and there is a possibility that Fulghum should be sown at even a higher rate than 10 pecks. The experiment with Fulghum undoubtedly should have included a 12-peck rate.

METHOD OF SEEDING

The open-furrow method of sowing winter oats sometimes is practiced in the South as a protection against injury from winterkilling. It consists of sowing the oats with a special drill in furrows from

3 to 5 inches deep and 1 foot apart. An experiment to determine the value of this method as compared with ordinary drilling was conducted at the Georgia State College of Agriculture during the seven years 1911 and 1913 to 1918, inclusive. The Red Rustproof variety was used and the plots were one-hundredth acre in size and in duplicate. The data from this experiment are given in Table 14.

TABLE 14.—*Yields obtained from method-of-seeding experiments with winter oats at the Georgia State College of Agriculture, Athens, for the seven years 1911 and 1913 to 1918, inclusive*

Method of seeding	Acre yields (bushels)							
	1911	1913	1914	1915	1916	1917	1918	Average
Open furrow	61.5	38.2	62.2	36.8	41.6	0	28.5	38.4
Ordinary drilling	61.7	39.8	64.2	36.4	45.3	0	13.5	37.3

The annual yields shown in Table 14 indicate that there is little difference between the two methods in average or favorable years. The annual yields for 1918 indicate that in the colder years the open furrow provides better protection than ordinary drilling. In that year yields of 28.5 and 13.5 bushels, respectively, were obtained from the two methods. It is evident, however, that the open furrow will not give perfect protection, as in 1917, when conditions were so severe, oats sown by both methods were killed.

METHOD OF SEED-BED PREPARATION

An experiment to determine the best method of seed-bed preparation for winter oats, in which plowing was compared with disking the land, was conducted at the Georgia State College of Agriculture during the six-year period from 1913 to 1918, inclusive. Disking makes it possible to prepare more land per day at less expense, thereby helping to get the crop in earlier. This experiment was conducted on land on which corn was grown during the summer. The corn was cut and shocked about September 1, and one seed bed was prepared by double disking with a disk harrow and another by plowing and harrowing. The seed was sown with a grain drill. The variety used was the Red Rustproof (Appler), and duplicate hundredth-acre plots were sown. The results obtained from this experiment are given in Table 15.

TABLE 15.—*Yields obtained in experiments on methods of seed-bed preparation for winter oats at the Georgia State College of Agriculture, Athens, during the six-year period from 1913 to 1918, inclusive*

Method of preparation	Acre yields (bushels)						
	1913	1914	1915	1916	1917	1918	Average
Land plowed	40.5	62.2	37.9	50.7	0	15.7	34.5
Land disked	46.6	64.2	35.3	36.2	0	25.3	34.6

In three of the five comparable years higher yields were obtained from disking than from plowing. On the basis of these data, together with the fact that plowing is at least three times as expensive as disking, the latter practice, apparently, is to be strongly recommended, especially where oats follow corn or soy beans and the land is reasonably free from crop residue and grass, as has been true at the Georgia State College of Agriculture. In southern Georgia, on the other hand, crops are "laid by" earlier, grass comes in, and it is not always possible to prepare a good seed bed without plowing. When plowing is necessary it should be done at as early a date as possible, in order to allow time for the seed bed to become settled, as a firm seed bed is one of the first essentials for the successful production of fall-sown oats.

PLACE IN ROTATION

In the northern portion of the Cotton Belt fall-sown oats usually follow corn or other cultivated crops. Owing to the fact that cotton does not usually mature sufficiently early to turn under the stalks in time for sowing winter oats, the practice of sowing this crop in the cotton "middles" with a one-horse drill just after the first picking of cotton in early October is becoming very common. In order to determine the value of this practice, an experiment was begun at the Georgia State College of Agriculture in 1919 in which winter oats followed corn and cotton, the land being plowed and treated similarly in each case. Duplicate plots of one-hundredth acre each of the Red Rustproof variety were sown. The annual and average yields for the six years 1919, 1920, and 1922 to 1925, inclusive, are given in Table 16. In 1921 the grain from these plots was completely destroyed by fire. In 1924 the crop was lost by winterkilling.

Table 16.—*Yields of winter oats following corn and cotton at the Georgia State College of Agriculture, Athens, during the six years 1919, 1920, and 1922 to 1925, inclusive*

Previous crop	Acre yields (bushels)						
	1919	1920	1922	1923	1924 [1]	1925	Average
Corn	21.3	30.0	27.6	55.2	0	28.7	27.1
Cotton	15.5	27.1	43.9	46.6	0	42.6	29.3

[1] No yields were obtained because of winterkilling.

The average yield for the six years is slightly in favor of the oats following cotton, but the yearly variations are so great that from this experiment neither method can be recommended over the other. More data are needed to warrant conclusions. The results of experiments which have been conducted elsewhere indicate lower yields than where the land is plowed, and the practicability of the method depends on whether the higher yield will be offset by the cost of plowing. In general, the factor determining the place of fall-sown oats in the rotation depends on what crop can be removed in time to permit the early sowing of the oats.

FERTILIZERS FOR FALL-SOWN OATS

Fertilizer experiments with fall-sown oats in Georgia included tests of acid phosphate in combination with ammonium sulphate and in combination with both ammonium sulphate and muriate of potash at a number of different points in the Piedmont Plateau and the Coastal Plain sections. Experiments to determine the best time of applying nitrogenous fertilizers, principally nitrate of soda, to the growing oat plant in the spring also were conducted at four stations in Georgia.

COMPLETE FERTILIZERS

In 28 experiments with winter oats, conducted on 7 different soils of the Piedmont Plateau, and 35 experiments on 11 different soils of the Coastal Plain, acid phosphate and muriate of potash were applied before sowing, and ammonium sulphate was applied in the early spring from February 15 to March 15, depending on the location in the State. The average yields obtained from these fertilizer treatments for the two sections of the State are given in Table 17.

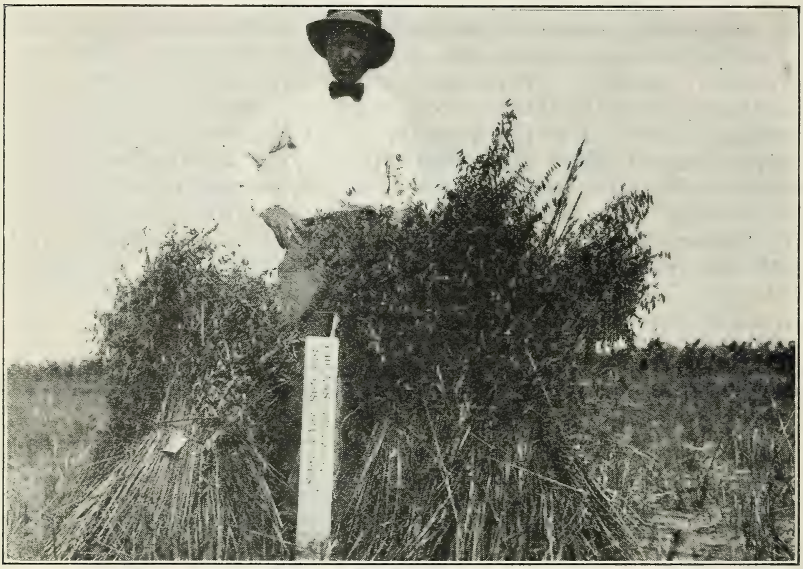

FIG. 9.—Fall-sown oats grown on plot with no fertilizer (at left); fall-sown oats grown on plot treated with acid phosphate and ammonium sulphate applied at the rates of 400 and 140 pounds per acre, respectively (at right)

TABLE 17.—*Summarized average yields of winter oats obtained from 28 experiments on the Piedmont Plateau and 35 experiments on the Coastal Plain, where acid phosphate was applied with ammonium sulphate alone or with both ammonium sulphate and muriate of potash*

Fertilizer application	Acre yields (bushels)	
	Piedmont Plateau	Coastal Plain
No fertilizer	11.3	10.2
400 pounds of acid phosphate and 140 pounds of ammonium sulphate	23.0	15.9
400 pounds of acid phosphate, 140 pounds of ammonium sulphate, and 100 pounds of muriate of potash	23.5	17.7

The use of acid phosphate and ammonium sulphate on the average more than doubled the yield of oats on the Piedmont Plateau, and on the Coastal Plain the increase was from 50 to 60 per cent. Muriate of potash gave a slight increase in yield when applied to the sandy soils of the Coastal Plain. When potash was not applied the straw grown on these soils was weak and yields were reduced. On such soils the use of muriate of potash seems desirable. The data show that the application of muriate of potash does not pay on Piedmont soils.

Bundles of grain from unfertilized and fertilized plots of fall-sown oats are shown in Figure 9.

TIME OF APPLYING NITROGENOUS FERTILIZERS

Experiments were conducted to determine the proper time of applying fertilizers to fall-sown oats. Acid phosphate was applied at seeding at the rate of 400 pounds per acre. In the spring nitrate of soda at the rate of 100 pounds per acre or ammonium sulphate at the rate of 80 pounds per acre was applied as a top-dressing. The spring applications were made on different dates to determine the most effective time of application. These experiments, conducted at Athens, Ashburn, Tifton, and Quitman, covered periods varying from two to five years. The data are given in Table 18.

Table 18.—*Comparison of yields of winter oats at four localities in Georgia from the application of fertilizers at different dates during two or more years in the period from 1915 to 1917 and 1921 to 1925, inclusive*

[On the date stated application of a nitrate as a top-dressing was made in the form of either nitrate of soda (100 pounds per acre) or ammonium sulphate (80 pounds per acre)]

Locality and application	Acre yields (bushels)															
	1915	1916	1917	1921	1922	1923	1924	1925	Average							
									1922 to 1925	Increase or decrease over no nitrate	1915 and 1916	Increase or decrease over first date of applying	1921 to 1925	Increase or decrease over no nitrate	1915 to 1917	Increase or decrease over first date of applying
State College of Agriculture, Athens:																
No nitrate	---	---	---	---	52. 4	22. 1	0	38. 1	28. 2	0	---	---	---	---	---	---
Jan. 15	---	---	---	---	57. 5	30. 1	0	47. 2	33. 7	+5. 5	---	---	---	---	---	---
Feb. 1	---	---	---	---	52. 2	34. 5	0	43. 5	32. 6	+4. 4	---	---	---	---	---	---
Feb. 15	---	---	---	---	53. 7	34. 1	0	57. 3	36. 3	+8. 1	---	---	---	---	---	---
Mar. 1	---	---	---	---	61. 9	36. 2	0	58. 9	39. 3	+11. 1	---	---	---	---	---	---
Mar. 15	---	---	---	---	59. 8	35. 7	0	57. 9	38. 4	+10. 2	---	---	---	---	---	---
Apr. 1	---	---	---	---	56. 5	32. 3	0	52. 1	35. 2	+7. 0	---	---	---	---	---	---
Farm of J. S. Shingler, Ashburn:																
No nitrate	---	27. 5	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Jan. 15	17. 5	40. 6	---	---	---	---	---	---	---	---	29. 1	0	---	---	---	---
Feb. 1	23. 1	32. 5	---	---	---	---	---	---	---	---	27. 8	−1. 3	---	---	---	---
Feb. 15	21. 9	41. 2	---	---	---	---	---	---	---	---	31. 6	+2. 5	---	---	---	---
Mar. 1	24. 4	33. 1	---	---	---	---	---	---	---	---	28. 8	−. 3	---	---	---	---
Mar. 15	21. 9	28. 7	---	---	---	---	---	---	---	---	25. 3	−3. 8	---	---	---	---
Coastal Plain Experiment Station, Tifton:																
No nitrate	---	---	---	53. 0	37. 8	12. 4	17. 2	24. 2	---	---	---	---	28. 9	0	---	---
Jan. 15	---	---	---	60. 2	39. 9	12. 6	27. 3	26. 4	---	---	---	---	33. 3	+4. 4	---	---
Feb. 1	---	---	---	69. 7	42. 1	12. 1	28. 9	27. 1	---	---	---	---	36. 0	+7. 1	---	---
Feb. 15	---	---	---	59. 7	37. 9	13. 2	28. 1	25. 6	---	---	---	---	32. 9	+4. 0	---	---
Mar. 1	---	---	---	48. 8	42. 7	11. 9	26. 9	26. 6	---	---	---	---	31. 4	+2. 5	---	---
Mar. 15	---	---	---	31. 6	39. 0	11. 4	16. 6	23. 0	---	---	---	---	24. 3	−4. 6	---	---
County farm, Quitman:																
No nitrate	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Jan. 15	24. 8	32. 8	17. 2	---	---	---	---	---	---	---	---	---	---	---	24. 9	0
Feb. 1	26. 2	32. 5	20. 3	---	---	---	---	---	---	---	---	---	---	---	26. 3	+1. 4
Feb. 15	21. 2	32. 1	15. 6	---	---	---	---	---	---	---	---	---	---	---	23. 0	−1. 9
Mar. 1	24. 0	33. 7	15. 6	---	---	---	---	---	---	---	---	---	---	---	24. 4	−. 5
Mar. 15	20. 6	25. 6	11. 7	---	---	---	---	---	---	---	---	---	---	---	19. 3	−5. 6

An application of 400 pounds of acid phosphate at time of seeding and a spring application of 100 pounds of nitrate of soda or of 80 pounds of ammonium sulphate as a top-dressing gave increased yields justifying the use of this combination for fall-sown oats on the Piedmont Plateau. Unfortunately, unfertilized control plots were not used, and as a result the true value of the acid phosphate can not be determined by the data. The best results at Athens were obtained from applying the nitrogenous fertilizer around March 1. Applications made as late as April 1 delay maturity and produce lower yields.

The data from the three stations in the Coastal Plain section are less favorable to the use of nitrogenous fertilizer as a top-dressing than those from the Piedmont. Profitable increases were obtained at Tifton only, the best time of applying being around February 1. Applied as late as March 15, the fertilizer resulted in a slight decrease in yield. The data from Ashburn and Quitman are too meager to be conclusive, but in general they agree with those from Tifton.

In addition to the experiments reported in Table 18, another experiment was conducted at Athens in which nitrate of soda was used in two applications, 50 pounds on February 15 and 50 pounds on March 15, or in one application of 100 pounds on February 15. Similar divided applications were made on March 15, and April 15. The data obtained are given in Table 19.

TABLE 19.—*Yields obtained from divided applications of nitrate of soda to fall-sown oats at the Georgia State College of Agriculture, Athens, in 1915, 1916, and 1920*

Time of applying	Single or divided	Quantity applied (pounds)	Acre yields (bushels)			
			1915	1916	1920	Average
Feb. 15	One application	100	19.2	45.4	40.8	35.1
Do	Divided application	50}=100	24.4	44.8	54.6	41.3
Mar. 15	do	50				
Do	One application	100	25.8	46.1	48.7	40.2
Do	Divided application	50}=100	25.2	43.1	44.4	37.6
Apr. 15	do	50				

In this experiment fertilizer applied about March 15, either in a complete application or as part of a divided application, gave better results than when used earlier or later. The experiment where fertilizer was applied on various dates from January 15 to April 1 showed the best results from the March 1 application and slightly better results from the March 15 than from the February 15 application. The data from this experiment agree with those of the other experiment. Except for the early dates in 1920, the data show no advantage in dividing the quantity of nitrate of soda to be used and applying it in two lots. The applications of nitrate of soda should be made at times when the plants are free from moisture.

SUMMARY

From 2,000,000 to 3,000,000 acres of fall-sown oats are grown annually in the South. In the Carolinas, Georgia, Alabama, Mississippi, and Louisiana considerably more than 50 per cent of the oat acreage is devoted to the fall-sown crop.

Winter temperature is the limiting factor in fall-sown oat production, the northern limit being defined by the isotherm of 30° F.

The area lying between isotherms 30° and 20° F. constitutes a transitional zone in which both fall-sown and spring-sown oats are grown. In this area only the hardier varieties of fall-sown oats can be grown successfully. South of isotherm 20° F. fall-sown oats is a fairly certain crop, except in unusually cold seasons, when stands are reduced by winterkilling. Here strains of the so-called warm-climate varieties, Red Rustproof and Fulghum, are better adapted than the hardier ones, such as Winter Turf.

The development of varieties of fall-sown oats hardier than those now available is undoubtedly still the most pressing problem in connection with winter-oat improvement. Second in importance is the production of strains resistant to leaf rust.

During the last 15 years strains of the Winter Turf variety have produced the highest average yields in the plot varietal experiments at the Arlington Experiment Farm, Rosslyn, Va. The Culberson strains rank second. Red Rustproof and Fulghum can not compete with the first-named varieties because of lack of winter resistance. Lee, a new variety developed from a hybrid between Winter Turf and Aurora, has produced the highest average yield of all varieties during the years in which it has been tested.

In nursery experiments strains of certain tender types such as Fulghum and Hatchett have produced higher yields than in field plots, equaling those of the Winter Turf and Culberson varieties. This probably is partially explained by the better winter protection afforded by the method of nursery planting. Recent selections representing winter forms of the Fulghum oat have been exceedingly promising in yield.

Varietal experiments have been conducted at Athens, Ashburn, Tifton, and Quitman, Ga. At Athens, in northern Georgia, Hasting (Hundred Bushel), Bancroft, and Coker Appler, all strains of the Red Rustproof variety, have given the highest average yields. Fulghum has been a close second to the Hasting and Bancroft strains in average yield. Winter Turf and Culberson are poorly adapted to Georgia conditions. At Tifton, in southern Georgia, the Hasting (Hundred Bushel), Appler, Coker Appler, Bancroft, and Patterson strains of Red Rustproof all have slightly exceeded Fulghum in yield. Similar results were obtained at Quitman. At Ashburn, however, Fulghum decidedly outyielded the best Red Rustproof strains.

A summary of yield data from other southern stations indicates that in the Cotton Belt the various strains of the Red Rustproof and Fulghum varieties are the most satisfactory. Immediately north of the Cotton Belt hardier varieties, such as Winter Turf, Culberson, and Lee, are better adapted.

Results of a date-of-seeding experiment at Athens show that from October 10 to 18 is about the optimum date for sowing winter oats in northern Georgia. In southern Georgia seeding may be delayed until November 1, but, as a rule, slightly earlier seeding is safer. The results of these experiments on the whole indicate that late seeding is one of the factors responsible for the low yield of fall-sown oats in the South.

In a rate-of-seeding experiment with Red Rustproof and Fulghum oats at Athens the 6-peck rate for Red Rustproof and the 10-peck rate for Fulghum produced the highest average yields. Results at Tifton were similar.

The open-furrow method of sowing winter oats affords considerable protection against injury from winterkilling. In severely cold seasons, however, this method of seeding does not give perfect protection.

In an experiment conducted at Athens on corn ground, wherein methods of seed-bed preparation for oats were varied, double-disking produced as high yields as plowing, with the advantage of a decided decrease in the cost of production. Where the land has been well cultivated and is reasonably free from grass, weeds, and crop residue, disking is to be strongly recommended. Plowing should be resorted to only when the land is in such condition that a satisfactory seed bed can not be prepared by disking.

Rotation experiments indicate that oats should follow crops that can be removed from the land in time to permit early fall sowing of the oats.

Acid phosphate applied 200 to 400 pounds per acre in the fall at the time of seeding, with a top-dressing of nitrate of soda applied 100 to 150 pounds per acre about March 1, gave the best yields of any fertilizer combination tried. Ammonium sulphate applied 80 to 100 pounds per acre may be substituted for the nitrate of soda.

Experiments to determine the proper time of applying nitrogenous fertilizers to fall-sown oats indicate that in northern Georgia best results will be obtained when the application is made around March 1. In the Coastal Plain application should be about February 1. There was no advantage in dividing nitrogenous fertilizers and applying them in two separate applications.

Potash fertilizers paid for application on Coastal Plain soils, but not on Piedmont soils.

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